

Solicitation No.  
VA-101-12-RP-0140  
Project No. 640-424



**Department of  
Veterans Affairs**

## Specifications

**Vol. 2 of 7**

**For: Loop Road and Site Utilities**  
Radiology Consolidation  
Parking Structure 2

**At: VA Medical Center – Palo Alto**  
3801 Miranda Avenue  
Palo Alto, California 94304

Issue:

Open Bids:

Property of Department of Veterans Affairs

Amendment	
No.	Date



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**SECTION 01 45 29.01**

**TESTING LABORATORY SERVICES - LOOP ROAD AND SITE UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained and paid for by Contractor.

**1.2 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
1. T27-06 Sieve Analysis of Fine and Coarse Aggregates
  2. T96-02 (R2006) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  3. T99-01 (R2004) The Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
  4. T104-99 (R2003) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
  5. T180-01 (R2004) Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
  6. T191-02 (R2006) Density of Soil In-Place by the Sand-Cone Method
- C. American Concrete Institute (ACI):
1. 506.4R-94 (R2004) Guide for the Evaluation of Shotcrete
- D. American Society for Testing and Materials (ASTM):
1. A325-06 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
  2. A370-07 Definitions for Mechanical Testing of Steel Products
  3. A416/A416M-06 Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
  4. A490-06 Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
  5. C31/C31M-06 Making and Curing Concrete Test Specimens in the Field

6. C33-03 Concrete Aggregates
7. C39/C39M-05 Compressive Strength of Cylindrical Concrete Specimens
8. C109/C109M-05 Compressive Strength of Hydraulic Cement Mortars
9. C138-07 Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
10. C140-07 Sampling and Testing Concrete Masonry Units and Related Units
11. C143/C143M-05 Slump of Hydraulic Cement Concrete
12. C172-07 Sampling Freshly Mixed Concrete
13. C173-07 Air Content of freshly Mixed Concrete by the Volumetric Method
14. C330-05 Lightweight Aggregates for Structural Concrete
15. C567-05 Density Structural Lightweight Concrete
16. C780-07 Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
17. C1019-08 Sampling and Testing Grout
18. C1064/C1064M-05 Freshly Mixed Portland Cement Concrete
19. C1077-06 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
20. C1314-07 Compressive Strength of Masonry Prisms
21. D698-07 Laboratory Compaction Characteristics of Soil Using Standard Effort
22. D1143-07 Piles Under Static Axial Compressive Load
23. D1188-07 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
24. D1556-07 Density and Unit Weight of Soil in Place by the Sand-Cone Method
25. D1557-07 Laboratory Compaction Characteristics of Soil Using Modified Effort
26. D2166-06 Unconfined Compressive Strength of Cohesive Soil
27. D2167-94(R2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
28. D2216-05 Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
29. D2922-05 Density of soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
30. D2974-07 Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
31. D3666-(2002) Minimum Requirements for Agencies Testing and Inspection Bituminous Paving Materials



32. D3740-07 Minimum Requirements for Agencies Engaged in the Testing and Inspecting Road and Paving Material
  33. E94-04 Radiographic Testing
  34. E164-03 Ultrasonic Contact Examination of Weldments
  35. E329-07 Agencies Engaged in Construction Inspection and/or Testing
  36. E543-06 Agencies Performing Non-Destructive Testing
  37. E605-93(R2006) Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members
  38. E709-(2001) Guide for Magnetic Particle Examination
  39. E1155-96(R2008) Determining FF Floor Flatness and FL Floor Levelness Numbers
- E. American Welding Society (AWS):
1. D1.1/D1.1M-08 Structural Welding Code-Steel
  2. D1.8/D1.8M-05 Structural Welding Code - Seismic Supplement
- F. American Institute of Steel Construction (AISC):
1. 341-05 Seismic Provisions for Structural Steel Buildings, Including Supplement No. 1

### 1.3 REQUIREMENTS:

- A. Accreditation Requirements:
1. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e.; E 329, C 1077, D 3666, D3740, A 880, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the "Corporate Office."
  2. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by Resident Engineer. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Resident Engineer to such failure.
  3. Written Reports: Testing laboratory shall submit test reports to Resident Engineer, Contractor, unless other arrangements are agreed to in writing by the Resident Engineer. Submit reports of tests that fail to meet construction contract requirements on colored paper.
  4. Verbal Reports: Give verbal notification to Resident Engineer immediately of any irregularity.
  5. All earthwork and foundation installation shall be observed by the

Geotechnical Engineer to be contracted by the Government or Contractor, whichever is agreed to.

6. For Seismic Load Resisting System (SLRS), Welding Inspectors shall be provided as required by Appendix W, Section W3 of AISC 341.
7. Laboratories engaged in non-destructive testing (NDT) shall meet the requirements of ASTM E543 and Appendix W, Section W3 of AISC 341

## **PART 2 - PRODUCTS (Not Used)**

## **PART 3 - EXECUTION**

### **3.1 EARTHWORK:**

- A. General: All earthwork, including site and subgrade preparation, foundation and retaining wall installation, and fill placement, shall be performed in accordance with the geotechnical report titled "Geotechnical Investigation, Phase 2 Improvements - Packages 1, 2, 3, and 5, Veteran Affairs Medical Center, Palo Alto, California," prepared by Treadwell & Rollo, A Langan Company, dated 29 August 2011. The Geotechnical Engineer shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:
  1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the Resident Engineer regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to Resident Engineer extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
  2. Provide full time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
  3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.
- B. Testing Compaction:
  1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with ASTM D1557.
  2. Make field density tests in accordance with the primary testing method following ASTM D2922 wherever possible. Field density tests shall meet the optimum moisture content and relative compaction requirements specified in the geotechnical report. Field density tests utilizing

ASTM D1556, or ASTM D2167 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the Resident Engineer before the tests are conducted.

- a. Building Slab Subgrade: At least one test of subgrade for every 185m<sup>2</sup> (2000 square feet) of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one test for every 185 m<sup>2</sup> (2000 square feet) of overlaying building slab, but in no case fewer than three tests.
- b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
- c. Pavement Subgrade: One test for each 335 m<sup>2</sup> (400 square yards), but in no case fewer than two tests.
- d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
- e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
- f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to Resident Engineer. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed soils have been removed, bottom and sides of excavation are moist, and correlate actual soil conditions observed with those indicated by test borings.

- C. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- D. Testing Materials: Test suitability of on-site and off-site borrow as directed by Resident Engineer.

### **3.2 LANDSCAPING:**

- A. Test topsoil for organic materials, pH, phosphate, potash content, and gradation of particles.
  1. Test for organic material by using ASTM D2974.
  2. Determine percent of silt, sand, clay, and foreign materials such as rock, roots, and vegetation.
- B. Submit laboratory test report of topsoil to Resident Engineer.

### **3.3 ASPHALT CONCRETE PAVING:**

- A. Aggregate Base Course:
  1. Determine maximum density and optimum moisture content for aggregate

base material in accordance with ASTM D1557, Method D.

2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with ASTM D2922.
3. Sample and test aggregate as necessary to insure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.

B. Asphalt Concrete:

1. Aggregate: Sample and test aggregates in stock pile and hot-bins as necessary to insure compliance with specification requirements for gradation (AASHTO T27), wear (AASHTO T96), and soundness (AASHTO T104).
2. Temperature: Check temperature of each load of asphalt concrete at mixing plant and at site of paving operation.
3. Density: Make a minimum of two field density tests in accordance with ASTM D1188 of asphalt base and surface course for each day's paving operation.

**3.4 SITE WORK CONCRETE:**

- A. Test site work concrete including materials for concrete as required in Article CONCRETE of this section.

**3.5 CONCRETE:**

A. Batch Plant Inspection and Materials Testing:

1. Perform continuous batch plant inspection until concrete quality is established to satisfaction of Resident Engineer with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by Resident Engineer.
2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to Resident Engineer.
3. Sample and test mix ingredients as necessary to insure compliance with specifications.
4. Sample and test aggregates daily and as necessary for moisture content. Test the dry rodded weight of the coarse aggregate whenever a sieve analysis is made, and when it appears there has been a change in the aggregate.
5. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

B. Field Inspection and Materials Testing:

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.

2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 40 m<sup>3</sup> (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. After good concrete quality control has been established and maintained as determined by Resident Engineer make three cylinders for each 80 m<sup>3</sup> (100 cubic yards) or less of each concrete type, and at least three cylinders from any one day's pour for each concrete type. Label each cylinder with an identification number. Resident Engineer may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m<sup>3</sup> (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m<sup>3</sup> (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
  - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
  - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs,

mechanical coupler installation and grade of steel prior to concrete placement. Submit detailed report of observations.

12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
  - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
  - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
  - a. Monitor and record amount of water added at project site.
  - b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
  - a. Perform Floor Tolerance Measurements  $F_F$  and  $F_L$  in accordance with ASTM E1155. Calculate the actual overall F-numbers using the inferior/superior area method.
  - b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
  - c. Provide the Contractor and the Resident Engineer with the results of all profile tests, including a running tabulation of the overall  $F_F$  and  $F_L$  values for all slabs installed to date, within 72 hours after each slab installation.
19. Other Inspections:
  - a. Grouting under base plates.
  - b. Grouting anchor bolts and reinforcing steel in hardened concrete.
  - c. Wedge and Adhesive anchor installations.

C. Laboratory Tests of Field Samples:

1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by Resident Engineer. Compile laboratory test reports as follows: Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.
2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
3. Furnish certified compression test reports (duplicate) to Resident

Engineer. In test report, indicate the following information:

- a. Cylinder identification number and date cast.
- b. Specific location at which test samples were taken.
- c. Type of concrete, slump, and percent air.
- d. Compressive strength of concrete in MPa (psi).
- e. Weight of lightweight structural concrete in kg/m<sup>3</sup> (Pounds per cubic feet).
- f. Weather conditions during placing.
- g. Temperature of concrete in each test cylinder when test cylinder was molded.
- h. Maximum and minimum ambient temperature during placing.
- i. Ambient temperature when concrete sample in test cylinder was taken.
- j. Date delivered to laboratory and date tested.

### **3.6 REINFORCEMENT:**

- A. Review mill test reports furnished by Contractor.
- B. Perform sampling at fabricating plant. Take two samples from each 23 t (25 tons) or fraction thereof of each size of reinforcing steel No. 10 thru No. 57 (No. 3 thru No. 18).
- C. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.
- D. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.
- E. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

### **3.7 ARCHITECTURAL PRECAST CONCRETE:**

- A. Inspection at Plant: Forms, placement of reinforcing steel, concrete cover, and placement and finishing of concrete.
- B. Concrete Testing: Test concrete including materials for concrete as required in Article CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.
- C. Inspect members to insure specification requirements for curing and finishes have been met.

### **3.8 STRUCTURAL STEEL:**

- A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code. For the Seismic Load Resisting System (SLRS), additional inspection and testing requirements are to be performed as required in AWS 1.8 Structural Welding Code - Seismic Supplement and AISC 341 - Seismic Provisions, and these

provisions.

B. Prefabrication Inspection:

1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
2. Approve welding procedure qualifications either by pre-qualification or by witnessing qualifications tests.
3. Approve welder qualifications by certification or retesting.
4. Approve procedure for control of distortion and shrinkage stresses.
5. Approve procedures for welding in accordance with applicable sections of AWS D1.1.
6. For members of the SLRS, provide additional testing, inspection and documentation requirements for both welding and bolting as noted in AISC 341 for the Quality Assurance (QA) activity as required by Section Q5 through Q5.4.

C. Fabrication and Erection:

1. Weld Inspection:
  - a. Inspect welding equipment for capacity, maintenance and working condition.
  - b. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
  - c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
  - d. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
  - e. Measure 25 percent of fillet welds.
  - f. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
    - 1) 20 percent of all shear plate fillet welds at random, final pass only.
    - 2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
    - 3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
    - 4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.
    - 5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
  - g. Welding Ultrasonic Testing: Test in accordance with ASTM E164 and AWS D1.1 for 100 percent of all full penetration welds, braced and moment frame column splices, and a minimum of 20 percent of all other partial penetration column splices, at random.
  - h. Welding Radiographic Testing: Test in accordance with ASTM E94, and AWS D1.1 for 5 percent of all full penetration welds at random.



- i. Verify that correction of rejected welds are made in accordance with D1.1.
  - j. Testing and inspection do not relieve the Contractor of the responsibility Testing and inspection do not relieve the Contractor of the responsibility specified requirements.
- 2. Bolt Inspection:
  - a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
  - b. Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
  - c. Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of connections in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
  - d. Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
  - e. Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
  - f. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Inspection/Tests of Shear Connectors: Inspect all field welding operations for shear connectors. Check contractor's equipment daily according to manufacturer's recommendations. At the beginning of each day's work, test 2 welded shear connectors that have been installed that day. Subject the test shear connectors to a 30 degree bend test by striking with a heavy hammer or bending by placing a pipe over the stud and mechanically bending the stud. After the test, verify the weld section does not exhibit any tearing or cracking. If bend test is performed on the Work, replace each connector bent as part of this testing with a new connector at no cost to the Owner. Visually examine production-welded studs for full 360 degree flash with no evidence of undercut into the stud base. Test 10 percent of production-welded connectors with a hammer to approximately a 15-degree angle to ensure proper installation. Where no evidence of failure is observed, the tested shear connector may be left in the bent position. If a shear connector fails, perform a 30-degree bend test on 10 percent of that day's and the ensuing day's connector installation until there are no failures in 25 consecutive bend tests. Replace failed shear connectors with new shear connectors.
- E. For members of the SLRS provide additional testing, inspection and documentation requirements for both welding and bolting as specified in AISC 341 for the Quality Assurance (QA) tasks and documentation as required by Section Q5 through Q5.4, and W4.1 and 4.2, and Sections W6.2 and W6.3 of AISC 341-05 for Demand Critical Welds.

- F. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to Resident Engineer.

**3.9 STEEL DECKING:**

- A. Provide field inspection of welds of metal deck to the supporting steel, and testing services to insure steel decking has been installed in accordance with contract documents and manufacturer's requirements.
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with "Welder Qualification" procedures of AWS D1.1. Refer to the "Plug Weld Qualification Procedure" in Part 3 "Field Quality Control."
- C. Submit inspection reports, certification, and instances of noncompliance to Resident Engineer.

**3.10 SHEAR CONNECTOR STUDS:**

- A. Provide field inspection and testing services required by AWS D.1 to insure shear connector studs have been installed in accordance with contract documents.
- B. Tests: Test 20 percent of headed studs for fastening strength in accordance with AWS D1.1.
- C. Submit inspection reports, certification, and instances of noncompliance to Resident Engineer.

**3.11 TYPE OF TEST:**

Approximate Number  
of Tests Required

- A. Earthwork:  
Laboratory Compaction Test, Soils:  
    (ASTM D1557) Art. 3.1.B  
    Field Density, Soils ASTM D2922 Art. 3.1.B  
    Penetration Test, Soils Art. 3.1.B
- B. Landscaping:  
    Topsoil Test Art. 3.2.A
- C. Aggregate Base:  
Laboratory Compaction, (ASTM D1557) Art. 3.3.A  
Field Density, ASTM D2922 Art. 3.3.A  
    Aggregate, Base Course  
Gradation (AASHTO T27) Art. 3.3.A  
Wear (AASHTO T96) Art. 3.3.A  
Soundness (AASHTO T104) Art. 3.3.A

D.	Asphalt Concrete:	
	Field Density, (ASTM D1188)	Art. 3.3.B
	Aggregate, Asphalt Concrete	
	Gradation (AASHTO T27)	Art. 3.3.B
	Wear (AASHTO T96)	Art. 3.3.B
	Soundness (AASHTO T104)	Art. 3.3.B
E.	Concrete:	
	Making and Curing Concrete Test Cylinders (ASTM C31)	100
	Compressive Strength, Test Cylinders (ASTM C39)	100
	Concrete Slump Test (ASTM C143)	25
	Concrete Air Content Test (ASTM C173)	25
	Unit Weight, Lightweight Concrete (ASTM C567)	5
	Aggregate, Normal Weight:	
	Gradation (ASTM C33)	5
	Deleterious Substances (ASTM C33)	5
	Soundness (ASTM C33)	5
	Abrasion (ASTM C33)	5
	Aggregate, Lightweight	
	Gradation (ASTM C330)	5
	Deleterious Substances (ASTM C330)	5
	Unit Weight (ASTM C330)	5
	Flatness and Levelness Readings (ASTM E1155) (number of days)	4
F.	Reinforcing Steel:	
	Tensile Test (ASTM A370)	5
	Bend Test (ASTM A370)	5
	Mechanical Splice (ASTM A370)	2
	Welded Splice Test (ASTM A370)	2
G.	Structural Steel:	
	Ultrasonic Testing of Welds (ASTM E164)	10
	Magnetic Particle Testing of Welds (ASTM E709)	100
	Radiographic Testing of Welds (ASTM E94)	10
	Shear Connectors	20

- - - E N D - - -



**SECTION 01 81 11.01**

**SUSTAINABLE DESIGN REQUIREMENTS - LOOP ROAD AND SITE UTILITIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section describes general requirements and procedures to comply with the Guiding Principles for Leadership in High Performance and Sustainable Buildings Memorandum of Understanding incorporated in the Executive Orders 13423 and 13514; Energy Policy Act of 2005 (EPA 2005) and the Energy Independence and Security Act of 2007 (EISA 2007); and U.S. Green Building Council (USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver certification as a minimum based on USGBC's "LEED 2009 for New Construction and Major Renovations."

**1.2 OBJECTIVES**

- A. Provide Work as required to meet and satisfy anticipated LEED prerequisites and credits listed on the LEED score card attached to this Section.
- B. To obtain acceptable Indoor Air Quality (IAQ) for the completed project and minimize the environmental impacts of the construction and operation, the Contractor during the construction phase of this project shall implement the following procedures:
1. Select products that minimize consumption of non-renewable resources, consume reduced amounts of energy and minimize amounts of pollution to produce, and employ recycled and/or recyclable materials. It is the intent of this project to conform with EPA's Five Guiding Principles on environmentally preferable purchasing. The five principles are:
    - a. Include environmental considerations as part of the normal purchasing process.
    - b. Emphasize pollution prevention early in the purchasing process.
    - c. Examine multiple environmental attributes throughout a product's or service's life cycle.
    - d. Compare relevant environmental impacts when selecting products and services.
    - e. Collect and base purchasing decisions on accurate and meaningful information about environmental performance.
  2. Control sources for potential IAQ pollutants by controlled selection of materials and processes used in project construction in order to attain superior IAQ.
  3. Products and processes that achieve the above objectives to the extent currently possible and practical have been selected and included in these Construction Documents. The Contractor is responsible to maintain and support these objectives in developing means and methods

for performing the work of this Contract and in proposing product substitutions and/or changes to specified processes.

4. Use building practices that insure construction debris and particulates do not contaminate or enter duct work prior to system startup and turn over.

### **1.3 RELATED DOCUMENTS**

- A. Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT
- B. Section 01 81 09 TESTING FOR INDOOR AIR QUALITY (not written yet)
- C. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS

### **1.4 DEFINITIONS**

- A. Agrifiber Products: Composite panel products derived from agricultural fiber
- B. Biobased Product: As defined in the 2002 Farm Bill, a product determined by the Secretary to be a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials
- C. Biobased Content: The weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight
- D. Certificates of Chain-of-Custody: Certificates signed by manufacturers certifying that wood used to make products has been tracked through its extraction and fabrication to ensure that it was obtained from forests certified by a specified certification program
- E. Composite Wood: A product consisting of wood fiber or other plant particles bonded together by a resin or binder
- F. Construction and Demolition Waste: Includes solid wastes, such as building materials, packaging, rubbish, debris, and rubble resulting from construction, remodeling, repair and demolition operations. A construction waste management plan is to be provided by the Contractor as defined in Section 01 74 19.
- G. Third Party Certification: Certification of levels of environmental achievement by nationally recognized sustainability rating system.
- H. Light Pollution: Light that extends beyond its source such that the additional light is wasted in an unwanted area or in an area where it inhibits view of the night sky
- I. Recycled Content Materials: Products that contain pre-consumer or post-consumer materials as all or part of their feedstock

- J. Post-Consumer Recycled Content: The percentage by weight of constituent materials that have been recovered or otherwise diverted from the solid-waste stream after consumer use
- K. Pre-Consumer Recycled Content: Materials that have been recovered or otherwise diverted from the solid-waste stream during the manufacturing process. Pre-consumer content must be material that would not have otherwise entered the waste stream as per Section 5 of the FTC Act, Part 260 "Guidelines for the Use of Environmental Marketing Claims":
  - 1. [www.ftc.gov/bcp/grnrule/guides980427](http://www.ftc.gov/bcp/grnrule/guides980427)
- L. Regional Materials: Materials that are extracted, harvested, recovered, and manufactured within a radius of 250 miles (400 km) from the Project site
- M. Salvaged or Reused Materials: Materials extracted from existing buildings in order to be reused in other buildings without being manufactured
- N. Sealant: Any material that fills and seals gaps between other materials
- O. Type 1 Finishes: Materials and finishes which have a potential for short-term levels of off gassing from chemicals inherent in their manufacturing process, or which are applied in a form requiring vehicles or carriers for spreading which release a high level of particulate matter in the process of installation and/or curing.
- P. Type 2 Finishes: "Fuzzy" materials and finishes which are woven, fibrous, or porous in nature and tend to adsorb chemicals offgas.
- Q. Volatile Organic Compounds (VOCs): Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. Compounds that have negligible photochemical reactivity, listed in EPA 40 CFR 51.100(s), are also excluded from this regulatory definition.

## **1.5 SUBMITTALS**

- A. Sustainable Design Submittals:
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form attached to this Section; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
    - a. Electronic file (.pdf) of LEED Product Data Submittal Form is available from the Resident Engineer.
  - 3. Heat Island Effect:
    - a. Site Paving: Provide manufacturer's cut sheets for all impervious paving materials, highlighting the Solar Reflectance Index (SRI) of the material. Also, provide cut sheets for all pervious paving materials.

- b. Roofing Materials: Submittals for roofing materials must include manufacturer's cut sheets or product data highlighting the Solar Reflectance Index (SRI) of the material.
- 4. Exterior Lighting Fixtures: Submittals must include cut sheets with manufacturer's data on initial fixture lumens above 90° from nadir for all exterior lighting fixtures, and, for parking lot lighting, verification that the fixtures are classified by the IESNA as "full cutoff" (FCO); OR provide documentation that exterior luminaires are IDA-Approved as Dark-Sky Friendly by the International Dark Sky Association (IDA) Fixture Seal of Approval Program.
- 5. Irrigation Systems: Provide manufacturer's cut sheets for all permanent landscape irrigation system components and for any rainwater harvesting system components, such as cisterns.
- 6. Water Conserving Fixtures: Submittals must include manufacturer's cut sheets for all water-consuming plumbing fixtures and fittings (toilets, urinals, faucets, showerheads, etc.) highlighting maximum flow rates and/or flush rates. Include cut sheets for any automatic faucet-control devices.
- 7. Elimination of CFCs AND HCFCs: Provide manufacturer's cut sheets for all cooling equipment with manufacturer's product data, highlighting refrigerants; provide manufacturer's cut sheets for all fire-suppression equipment, highlighting fire-suppression agents; provide manufacturer's cut-sheets for all polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation, highlighting the blowing agent(s).
- 8. Appliances and Equipment: Provide copies of manufacturer's product data for all Energy Star eligible equipment and appliances, including office equipment, computers and printers, electronics, and commercial food service equipment (excluding HVAC and lighting components), verifying compliance with EPA's Energy Star program.
- 9. On-Site Renewable Energy Systems: Provide cut sheets and manufacturer's product data for all on-site renewable energy generating components and equipment, including documentation of output capacity.
- 10. Measurement and Verification Systems: Provide cut sheets and manufacturer's product data for all controls systems, highlighting electrical metering and trending capability components.
- 11. Recycled Content: Submittals for all materials with recycled content (excluding MEP systems equipment and components) must include the following documentation:
  - a. List of each material or product, excluding cost of labor and equipment for installation
  - b. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the percentage of post-consumer and pre-consumer recycled content (by weight) of each material or product
  - c. An electronic spreadsheet that tabulates the Project's total materials cost and combined recycled content value (defined as the sum of the post-consumer recycled content value plus one-half of the pre-consumer recycled content value) expressed as a



percentage of total materials cost. This spreadsheet shall be submitted every third month with the Contractor's Certificate and Application for Payment. It should indicate, on an ongoing basis, line items for each material, including cost, pre-consumer recycled content, post-consumer recycled content, and combined recycled content value.

12. Regional Materials: Submittals for all products or materials expected to contribute to the regional calculation (excluding MEP systems equipment and components) must include the following documentation:
  - a. Cost of each material or product, excluding cost of labor and equipment for installation
  - b. Location of product manufacture and distance from point of manufacture to the Project Site
  - c. Location of point of extraction, harvest, or recovery for each raw material in each product and distance from the point of extraction, harvest, or recovery to the Project Site
  - d. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the location and distance from the Project Site to the point of manufacture for each regional material
  - e. Manufacturer's product data, product literature, or a letter from the manufacturer verifying the location and distance from the Project Site to the point of extraction, harvest, or recovery for each regional material or product, including, at a minimum, gravel and fill, planting materials, concrete, masonry, and GWB
  - f. An electronic spreadsheet that tabulates the Project's total materials cost and regional materials value, expressed as a percentage of total materials cost. This spreadsheet shall be submitted every third month with the Contractor's Certificate and Application for Payment. It should indicate on an ongoing basis, line items for each material, including cost, location of manufacture, distance from manufacturing plant to the Project Site, location of raw material extraction, and distance from extraction point to the Project Site.
13. Biobased Products:
  - a. Rapidly Renewable Products: Submittals must include written documentation from the manufacturer declaring that rapidly renewable materials are made from plants harvested within a ten-year or shorter cycle and must indicate the percentage (by weight) of these rapidly renewable components contained in the candidate products, along with the costs of each of these materials, excluding labor and delivery costs.
  - b. Certified Wood: Submittals for all wood-based materials must include a statement indicating the cost of each product containing FSC Certified wood, exclusive of labor and delivery costs, and third party verification of certification from one of the following:
    - 1) Documentation from the supplier verifying that 100% of the wood-based content originates from SFI third-party certified forest lands, identifying the company or companies that performed the SFI third-party certification for both the forest land management and the certified

product content.

14. Outdoor Air Delivery Monitoring: Provide manufacturer's cut sheets highlighting the installed carbon dioxide monitoring system components and sequence of controls shop drawing documentation, including CO2 differential set-points and alarm capabilities.
15. Interior Adhesives and Sealants: Submittals for all field-applied adhesives and sealants, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content.
  - a. Provide manufacturers' documentation verifying all adhesives used to apply laminates, whether shop-applied or field-applied, contain no urea-formaldehyde.
16. Interior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on indoor air, must include manufacturer's MSDSs or other Product Data highlighting VOC content
17. Exterior Paints and Coatings: Submittals for all field-applied paints and coatings, which have a potential impact on ambient air quality, must include manufacturer's MSDSs or other manufacturer's Product Data highlighting VOC content.
18. Floorcoverings:
  - a. Carpet Systems: Submittals for all carpet must include the following:
    - 1) A copy of an assessment from the Building for Environmental and Economic Sustainability (BEES) software model, either Version 3.0 or 4.0, with parameters of the model set as described by this specification section.
    - 2) Manufacturer's product data verifying that all carpet systems meet or exceed the testing and product requirements of the Carpet and Rug Institute Green Label Plus program.
19. Composite Wood and Agrifiber Binders: Submittals for all composite wood and agrifiber products (including but not limited to particleboard, wheatboard, strawboard, agriboard products, engineered wood components, solid-core wood doors, OSB, MDF, and plywood products) must include manufacturer's product data verifying that these products contain no urea-formaldehyde resins.
20. Entryway Systems: Provide manufacturer's cut sheets for all walk-off systems installed to capture particulates, including permanently installed grates, grilles, slotted systems, direct glue-down walk-off mats, and non-permanent roll-out mats.
21. Air Filtration: Provide manufacturer's cut sheets and product data highlighting the following:
  - a. Minimum Efficiency Reporting Value (MERV) for filtration media in all air handling units (AHUs) per ASHRAE HVAC Design Manual for Hospitals and Clinics.
  - b. Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed AHUs are used during construction. See above for requirements
22. Mercury in Lighting: Provide manufacturer's cut sheets or product data

- for all fluorescent or HID lamps highlighting mercury content.
23. Lighting Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all lighting controls systems components.
  24. Thermal Comfort Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all thermal comfort-control systems components.
  25. Blended Cement: It is the intent of this specification to reduce CO2 emissions and other environmentally detrimental effects resulting from the production of portland cement by requiring that all concrete mixes, in aggregate, utilize blended cement mixes to displace portland cement as specified in Section 03 30 00, CONCRETE typically included in conventional construction. Provide the following submittals:
    - a. Copies of concrete design mixes for all installed concrete
    - b. Copies of typical regional baseline concrete design mixes for all compressive strengths used on the Project
    - c. Quantities in cubic yards of each installed concrete mix
  26. Gypsum Wall Board: Provide manufacturer's cut sheets or product data verifying that all gypsum wallboard products are moisture and mold-resistant.
  27. Fiberglass Insulation: Provide manufacturer's cut sheets or product data verifying that fiberglass batt insulation contains no urea-formaldehyde.
  28. Duct Acoustical Insulation: Provide manufacturer's cut sheets or product data verifying that mechanical sound insulation materials in air distribution ducts consists of an impervious, non-porous coatings that prevent dust from accumulating in the insulating materials.
  29. Green Housekeeping: Provide documentation that all cleaning products and janitorial paper products meet the VOC limits and content requirements of this specification section.
- B. Project Materials Cost Data: Provide a spreadsheet in an electronic file indicating the total cost for the Project and the total cost of building materials used for the Project, as follows:
1. Not more than 60 days after the Preconstruction Meeting, the General Contractor shall provide to the Resident Engineer a preliminary schedule of materials costs for all materials used for the Project organized by specification section. Exclude labor costs and all mechanical, electrical, and plumbing (MEP) systems materials and labor costs. Include the following:
    - a. Identify each reused or salvaged material, its cost, and its replacement value.
    - b. Identify each recycled-content material, its post-consumer and pre-consumer recycled content as a percentage the product's weight, its cost, its combined recycled content value (defined as the sum of the post-consumer recycled content value plus one-half of the pre-consumer recycled content value), and the total combined recycled content value for all materials as a percentage of total materials costs.

- c. Identify each regional material, its cost, its manufacturing location, the distance of this location from the Project site, the source location for each raw material component of the material, the distance of these extraction locations from the Project site, and the total value of regional materials as a percentage of total materials costs.
    - d. Identify each biobased material, its source, its cost, and the total value of biobased materials as a percentage of total materials costs. Also provide the total value of rapidly renewable materials (materials made from plants that are harvested in less than a 10-year cycle) as a percentage of total materials costs.
    - e. Identify each wood-based material, its cost, the total wood-based materials cost, each FSC Certified wood material, its cost, and the total value of Certified wood as a percentage of total wood-based materials costs.
  2. Provide final versions of the above spreadsheets to the Resident Engineer not more than 14 days after Substantial Completion.
- C. Construction Waste Management: See Section 01 74 19 "Construction Waste Management" for submittal requirements.
- D. Construction Indoor Air Quality (IAQ) Management: Submittals must include the following:
  1. Within 14 days of site mobilization, prepare and submit for the Resident Engineer's approval, an electronic copy of the draft Construction IAQ Management Plan in an electronic file including, but not limited to, descriptions of the following:
  2. Instruction procedures for meeting or exceeding the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings Under Construction, 1995, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling
    - a. Instruction procedures for protecting absorptive materials stored on-site or installed from moisture damage
    - b. Schedule of submission to Resident Engineer of photographs of on-site construction IAQ management measures such as protection of ducts and on-site stored oil installed absorptive materials
    - c. Instruction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille
    - d. Instruction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit
  3. Not more than 30 days following receipt of the approved draft CIAQMP, submit an electronic copy of the approved CIAQMP in an electronic file, along with the following:
    - a. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for all filtration

- media to be installed at return air grilles during construction if permanently installed AHUs are used during construction.
- b. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media in all air handling units (AHUs).
- 4. Not more than 14 days after Substantial Completion provide the following:
  - a. Documentation verifying required replacement of air filtration media in all air handling units (AHUs) after the completion of construction and prior to occupancy and, if applicable, required installation of filtration during construction.
  - b. Construction photographs: Ten photographs taken at different conditions, monthly during construction of the SMACNA approaches employed, along with a brief description of each approach, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
  - c. A copy of the report from testing and inspecting agency documenting the results of IAQ testing, demonstrating conformance with IAQ testing procedures and requirements defined in Section 01 81 09 "Testing for Indoor Air Quality."
- E. Commissioning: See Section 01 91 00 "General Commissioning Requirements" for submittal requirements.
- F. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports for the following:
  - 1. Construction Waste Management: Waste reduction progress reports and logs complying with the requirements of Section 01 74 19 "Construction Waste Management."
  - 2. Construction IAQ Management: See details below under Section 3.2 Construction Indoor Air Quality Management for Construction IAQ management progress report requirements.
  - 3. LEED Compliance: Updated status for meeting each LEED prerequisite and credit point indicated on LEED score card.

#### **1.6 QUALITY ASSURANCE**

- A. Preconstruction Meeting: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Resident Engineer, and all Subcontractors to discuss the Construction Waste Management Plan, the required Construction Indoor Air Quality (IAQ) Management Plan, and all other Sustainable Design Requirements. The purpose of this meeting is to develop a mutual understanding of the Project's Sustainable Design Requirements and coordination of the Contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.
- B. Construction Job Conferences: The status of compliance with the Sustainable Design Requirements of these specifications and attaining the LEED prerequisites and credit points indicated on the LEED score card will be

an agenda item at all regular job meetings conducted during the course of work at the site.

## **PART 2 - PRODUCTS**

### **2.1 PRODUCT ENVIRONMENTAL REQUIREMENTS**

- A. Site Clearing: Topsoil shall be provided by the Contractor from on-site material which has been stockpiled for reuse. Off-site borrow should only be used when on-site sources are exhausted. Chip and/or compost on site all vegetated material identified for removal.
- B. Do not burn rubbish, organic matter, etc. or any material on the site. Dispose of legally in accordance with Specifications Sections 01 74 19.
- C. Site Paving: All site impervious paving must be light colored, with a Solar Reflectance Index (SRI) of at least 29.
- D. Roofing Materials: All roofing systems, other than vegetated roof systems, must comply with the following requirements:
  - 1. Low-Sloped roofing less than or equal to 2:12 slope must have an SRI of at least 78.
  - 2. Steep-Sloped roofing greater than 2:12 slope must have an SRI of at least 29.
  - 3. Roofing Materials: Light-colored, reflective, and high-emissivity roofing helps to reduce localized heat build-up from roof surfaces that contribute to the urban heat island effect.
- E. Exterior Lighting Fixtures:
  - 1. All exterior luminaires must emit 0° of the total initial designed fixture lumens at an angle above 90° from nadir and/or meet the requirements of the Dark Sky certification program.
  - 2. Exterior lighting cannot exceed 80% of the lighting power densities defined by ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.
  - 3. No lighting of building facades or landscape features is permitted.
- F. Herbicides and Pest Control: Herbicides shall not be permitted, and pest control measures shall utilize EPA-registered biopesticides only.
- G. Water-Conserving Fixtures: Plumbing fixtures and fittings shall use in aggregate at least 40% less water than the water use baseline calculated for the building after meeting the Energy Policy Act of 1992 fixture performance requirements. Flow and flush rates shall be as indicated on Drawings, PLUMBING FIXTURE SCHEDULE.
- H. Elimination of CFCs AND HCFCs:
  - 1. Ozone Protection: Base building cooling equipment shall contain no refrigerants other than the following: HCFC-123, HFC-134a, HFC-245fa, HFC-407c, or HFC 410

2. Fire suppression systems may not contain ozone-depleting substances.
  3. Extruded polystyrene insulation (XPS) and closed-cell spray foam polyurethane insulation shall not be manufactured with hydrochlorofluorocarbon (HCFC) blowing agents.
- I. Appliances and Equipment: All Energy Star eligible equipment and appliances, including office equipment, computers and printers, electronics, and commercial food service equipment (excluding HVAC and lighting components), shall be qualified by EPA's Energy Star program.
- J. HVAC Distribution Efficiency:
1. All duct systems shall be constructed of galvanized sheet metal, aluminum, or stainless steel as deemed appropriate based on the application requirements. No fiberglass duct board shall be permitted.
  2. All medium- and high-pressure ductwork systems shall be pressure-tested in accordance with the current SMACNA standards.
  3. All ductwork shall be externally insulated. No interior duct liner shall be permitted.
  4. Where possible, all air terminal connections shall be hard-connected with sheet metal ductwork. If flexible ductwork is used, no flexible duct extension shall be more than six feet in length.
  5. All HVAC equipment shall be isolated from the ductwork system with flexible duct connectors to minimize the transmittance of vibration.
  6. All supply and return air branch ducts shall include the appropriate style of volume damper. Air terminal devices such as grilles, registers, and diffusers shall be balanced at duct branch dampers, not at terminal face.
- K. Measurement and Verification: Install controls and monitoring devices as required by MEP divisions order to comply with International Performance Measurement & Verification Protocol (IPMVP), Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003, Option D.
1. The IPMVP provides guidance on situation-appropriate application of measurement and verification strategies.
- L. Recycled Content of Materials:
1. Provide building materials with recycled content such that post-consumer recycled content value plus half the pre-consumer recycled content value constitutes a minimum of 30% of the cost of materials used for the Project, exclusive of all MEP equipment, labor, and delivery costs. The Contractor shall make all attempts to maximize the procurement of materials with recycled content.
    - a. The post-consumer recycled content value of a material shall be determined by dividing the weight of post-consumer recycled content by the total weight of the material and multiplying by the cost of the material.

- b. Do not include mechanical and electrical components in the calculations.
- c. Do not include labor and delivery costs in the calculations.
- d. Recycled content of materials shall be defined according to the Federal Trade Commission's "Guide for the Use of Environmental Marketing Claims," 16 CFR 260.7 (e).
- e. Utilize all on-site existing paving materials that are scheduled for demolition as granulated fill, and include the cost of this material had it been purchased in the calculations for recycled content value.
- f. The materials in the following list must contain the minimum recycled content indicated, or higher as required to meet LEED credit points indicated on the LEED score card:

Category	Minimum Recycled Content
Compost/mulch	100% post-consumer
Asphaltic Concrete Paving	25% post-consumer
Cast-in-Place Concrete	6% pre-consumer
CMU: Gray Block	20% pre-consumer
Steel Reinforcing Bars	90% combined
Structural Steel Shapes	90% combined
Steel Joists	75% combined
Steel Deck	75% combined
Steel Fabrications	60% combined
Steel Studs	30% combined
Steel Roofing	30% post-consumer
Aluminum Fabrications	35% combined
Rigid Insulation	20% pre-consumer
Batt insulation	30% combined

- M. VOC Content of Adhesives: Adhesives used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
- 1. Indoor Carpet Adhesives: 50 g/L.
  - 2. Carpet pad adhesives: 50 g/L.
  - 3. Wood flooring adhesives: 100 g/L.
  - 4. Rubber floor adhesives: 60 g/L.
  - 5. Subfloor adhesives: 50 g/L.
  - 6. Ceramic tile adhesives: 65 g/L.
  - 7. VCT and asphalt adhesives: 50 g/L.
  - 8. Drywall and panel adhesives: 50 g/L.
  - 9. Cove base adhesives: 50 g/L.
  - 10. Multipurpose construction adhesives: 70 g/L.
  - 11. Structural glazing adhesives: 100 g/L.
  - 12. PVC welding: 510 g/L.



13. CPVC welding: 490 g/L.
  14. ABS welding: 325 g/L.
  15. Plastic cement welding: 250 g/L.
  16. Adhesive primer for plastic: 550 g/L.
  17. Contact adhesive: 80 g/L.
  18. Special purpose contact adhesive: 250 g/L.
  19. Structural wood member adhesive: 140 g/L.
  20. Sheet applied rubber lining operations: 850 g/L.
  21. Top and trim adhesive: 250 g/L.
  22. Metal to metal adhesive: 30 g/L.
  23. Plastic foams adhesive: 50 g/L.
  24. Porous material (except wood) adhesive: 50 g/L.
  25. Wood adhesive: 30 g/L.
  26. Fiberglass adhesive: 80 g/L.
- N. VOC Content: Paints and coatings applied inside the weatherproofing system shall comply with VOC content limits of LEED NC v3.0; Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 3, Architectural Coatings; and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24); whichever is more stringent:
1. Interior Flat Coating or Primer: 50 g/L.
  2. Interior Nonflat Coating or Primer: 100 g/L.
  3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  4. Clear Wood Finishes (including varnish and sanding sealer): 350 g/L.
  5. Clear Wood Finishes (lacquer): 550 g/L.
  6. Clear Brushing Lacquer: 350 g/L.
  7. Shellacs, Clear: 730 g/L.
  8. Shellacs, Pigmented: 550 g/L.
  9. Interior Stains: 250 g/L.
  10. Waterproofing Concrete and Masonry Sealer: 100 g/L.
  11. Floor Coatings (Opaque Coatings): 100 g/L.
  12. Dry-Fog Coatings: 150 g/L.
- O. VOC Content: Paints and coatings applied on the exterior shall comply with VOC content limits of the Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 3, Architectural Coatings; which may be obtained from <http://www.baaqmd.gov>.

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# LEED PRODUCT SUBMITTAL DATA FORM

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Project: \_\_\_\_\_  
Architect: \_\_\_\_\_  
Specification Section No.: \_\_\_\_\_

Date: \_\_\_\_\_  
Project No.: \_\_\_\_\_  
Product: \_\_\_\_\_

Vendor/Installer/Subcontractor: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

Contact: \_\_\_\_\_  
Phone No.: \_\_\_\_\_  
Fax No.: \_\_\_\_\_  
www: \_\_\_\_\_

Contact: \_\_\_\_\_  
Phone No.: \_\_\_\_\_  
Fax No.: \_\_\_\_\_  
www: \_\_\_\_\_

## COST CERTIFICATION:

Total Installed Material Cost: \_\_\_\_\_  
(Excluding labor and equipment)

## CERTIFIED BY (Vendor/Subcontractor):

Print Name: \_\_\_\_\_  
Signature: \_\_\_\_\_  
Title: \_\_\_\_\_  
Date: \_\_\_\_\_

## PRODUCT CERTIFICATION:

### MR Credit 4: Recycled Content

Does this product have any recycled content? Yes No

If Yes, fill out the following information:

Post Consumer Recycled Content (% by weight) \_\_\_\_\_

Pre Consumer Recycled Content (% by weight) \_\_\_\_\_

Description of Recycled Content \_\_\_\_\_

Notes: Recycled content documentation must be attached.  
Specifications Divisions 14, 21, 22, 23, 25, 26, 27, and 28  
(MasterFormat 1995 Div. 14, 15, & 16) are exempt from this credit.

### MR Credit 6: Rapidly Renewable Materials

Does this product have any rapidly renewable materials  
(plants that are harvested within 10 years of planting) such  
as bamboo, wool, cotton, agrifiber, linoleum, wheatboard,  
strawboard, and cork? Yes No

If Yes, fill out the following information:

Percent that meets Credit (% by weight) \_\_\_\_\_

Description of Rapidly Renewable Material \_\_\_\_\_

### MR Credit 5: Regional Materials

Was a portion of this product extracted, harvested or  
recovered, as well as manufactured within 500 miles of the  
project site? Yes No

If Yes, fill out the following information:

Raw Material	Percent by Weight	Harvest Distance (miles)

Percent compliant by weight (%) \_\_\_\_\_

Manufacture Distance (miles) \_\_\_\_\_

Notes: Provide raw material extraction and manufacturing address.  
Verification letter from the manufacturer must be attached.  
Specifications Divisions 02 - 10 are eligible for this credit.

### MR Credit 7: Certified Wood

Does this product have wood based materials? Yes No

If Yes, fill out the following information:

Wood Component percentage (%) \_\_\_\_\_

FSC Certified wood percentage (%) \_\_\_\_\_

Product is FSC Trademarked \_\_\_\_\_

FSC Chain of Custody Certificate No. \_\_\_\_\_

Notes: Specification Division 02 - 10 are eligible for this credit.

A copy of the FSC Chain of Custody (COC) Certificate Number is  
required from the manufacturer if the product is FSC Trademarked  
for this submittal. (Generally fabricated products)

A copy of the FSC Chain of Custody (COC) Certificate Number is  
required from the supplier/vendor if the product is not fabricated  
in a FSC certified plant for this submittal. This includes (but is not  
limited to) all dimensional lumber and plywood. Invoices coming  
from delivery of certified wood, quantity, and suppliers COC is also  
required to jobsite superintendent upon final delivery of material.

## CERTIFIED BY (Manufacturer):

Print Name: \_\_\_\_\_  
Signature: \_\_\_\_\_  
Title: \_\_\_\_\_  
Date: \_\_\_\_\_

**INSTALLER/SUBCONTRACTOR CERTIFICATION:****IEQ Credit 4.1: Low Emitting Materials: Adhesives and Sealants**

List all interior adhesives and sealants applied on site (within the weatherproofing system) used in your scope of work

Adhesive and/or Sealant Used	Where Used	VOC (g/l)

**IEQ Credit 4.2: Low Emitting Materials: Paints and Coatings**

List all interior paints and coatings applied on site (within the weatherproofing system) used in your scope of work

Paint and/or Coating Used (including primers, anti-corrosive, anti-rust paints, clear finishes)	VOC (g/l)

**IEQ Credit 4.3: Low Emitting Materials: Flooring Systems**

List all carpets and flooring products used

Carpet (including carpet cushion) or Hard-Surface Flooring Product	CRI Green Label Plus Certification No. (carpet) or Floor Score Certification Shield (hard-surface flooring)
Adhesives (including aerosol adhesives) Used For Installation	VOC (g/l)

**IEQ Credit 4.4: Low Emitting Materials: Composite Wood and Agrifiber Products**

List all composite wood and/or agrifiber board used

Composite Wood and/or Agrifiber Product	No added urea-formaldehyde resins?
	Yes No
	Yes No
	Yes No
	Yes No
Adhesives Used to Manufacture/Fabricate (include laminating adhesives)	Does not contain urea-formaldehyde?
	Yes No
	Yes No
	Yes No

Note: Provide product data sheet or certification from manufacturer that no added urea-formaldehyde was used in the manufacturing of this product

**CERTIFIED BY (Installer/Subcontractor):**

Print Name \_\_\_\_\_

Signature: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

Note: Submittal of this form does not release the General Contractor from the responsibility of completing and submitting LEED Submittal Template to USGBC at the completion of this project.



# LEED 2009 for New Construction and Major Renovations

## Project Checklist

VAPA Loop Road and Site Utilities

CONSTRUCTION DOCUMENTS 25 MAY 2012

### 16 7 3 Sustainable Sites Possible Points: 26

Y	?	N			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
	5		Credit 2	Development Density and Community Connectivity	5
	1		Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
3			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
		1	Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
	1		Credit 6.1	Stormwater Design—Quantity Control	1
		1	Credit 6.2	Stormwater Design—Quality Control	1
		1	Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

### 2 2 6 Water Efficiency Possible Points: 10

Y	?	N			
Y			Prereq 1	Water Use Reduction—20% Reduction	
2		2	Credit 1	Water Efficient Landscaping	2 to 4
		2	Credit 2	Innovative Wastewater Technologies	2
	2	2	Credit 3	Water Use Reduction	2 to 4

### 11 24 Energy and Atmosphere Possible Points: 35

Y	?	N			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
4		15	Credit 1	Optimize Energy Performance	1 to 19
		7	Credit 2	On-Site Renewable Energy	1 to 7
		2	Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
2			Credit 6	Green Power	2

### 6 2 6 Materials and Resources Possible Points: 14

Y	?	N			
Y			Prereq 1	Storage and Collection of Recyclables	
		3	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
		2	Credit 3	Materials Reuse	1 to 2

### Materials and Resources, Continued

Y	?	N			
2			Credit 4	Recycled Content	1 to 2
1	1		Credit 5	Regional Materials	1 to 2
	1		Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

### 11 4 Indoor Environmental Quality Possible Points: 15

Y	?	N			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
		1	Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
		1	Credit 8.1	Daylight and Views—Daylight	1
		1	Credit 8.2	Daylight and Views—Views	1

### 2 4 Innovation and Design Process Possible Points: 6

Y	?	N			
	1		Credit 1.1	Innovation in Design: Specific Title	1
	1		Credit 1.2	Innovation in Design: Specific Title	1
	1		Credit 1.3	Innovation in Design: Specific Title	1
	1		Credit 1.4	Innovation in Design: Specific Title	1
1			Credit 1.5	EA4.1- Exemplary Perf.: Transp. Mgmt Plan VA Shuttle Bus	1
1			Credit 2	LEED Accredited Professional	1

### 4 Regional Priority Credits Possible Points: 4

Y	?	N			
1			Credit 1.1	Regional Priority: SSC1: Site Selection	1
1			Credit 1.2	Regional Priority: SSC4.1: Alternative Transportation- Public Transport	1
1			Credit 1.3	Regional Priority: WEc1.1: Water Efficient Landscaping	1
1			Credit 1.4	Regional Priority: EAc2: On Site Renewable Energy (1%)	1

### 52 15 43 Total Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110



**SECTION 01 91 00.01**

**GENERAL COMMISSIONING REQUIREMENTS - LOOP ROAD AND SITE UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures. The Commissioning Agent shall add, modify, and refine the commissioning procedures, as approved by the Department of Veterans Affairs (VA), to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the Division 7, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the VA and the Commissioning Agent to be indexed for future reference.
- D. Where training or educational services for VA are required and specified in other sections of the specifications, including but not limited to Division 7, Division 8, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.
- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the VA's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction, and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:
  - 1. Verify that the applicable equipment and systems are installed in accordance with the contact documents and according to the manufacturer's recommendations.

2. Verify and document proper integrated performance of equipment and systems.
  3. Verify that Operations & Maintenance documentation is complete.
  4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
  5. Verify that the VA's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
  6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.
- G. The Commissioning Agent, both the firm and individual designated as the Commissioning Agent, shall be certified by at least one of the following entities: the National Environmental Balancing Bureau (NEBB), the Associated Air Balance Council Commissioning Group (AABC), and the Building Commissioning Association (BCA). Certification(s) shall be valid and active. Proof of certification(s) shall be submitted to the Contracting Officer and the Resident Engineer three (3) calendar days after the Notice to Proceed.

## **1.2 CONTRACTUAL RELATIONSHIPS**

- A. For this construction project, the Department of Veterans Affairs contracts with a Contractor to provide construction services. The contracts are administered by the VA Contracting Officer and the Resident Engineer as the designated representative of the Contracting Officer. On this project, the authority to modify the contract in any way is strictly limited to the authority of the Contracting Officer and the Resident Engineer.
- B. In this structure, only two contract parties are recognized and communications on contractual issues are strictly limited to VA Resident Engineer and the Contractor. It is the practice of the VA to require that communications between other parties to the contracts (Subcontractors and Vendors) be conducted through the Resident Engineer and Contractor. It is also the practice of the VA that communications between other parties of the project (Commissioning Agent and Architect/Engineer) be conducted through the Resident Engineer.
- C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc) is essential to the success of the Commissioning effort.



- D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and Resident Engineer. Thus, the procedures outlined in this specification must be executed within the following limitations:
1. No communications (verbal or written) from the Commissioning Agent shall be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and the Contractor.
  2. Commissioning Issues identified by the Commissioning Agent will be delivered to the Resident Engineer and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Agent and as suggestions for resolution.
  3. In the event that any Commissioning Issues and suggested resolutions are deemed by the Resident Engineer to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or Resident Engineer will issue an official directive to this effect.
  4. All parties to the Commissioning Process shall be individually responsible for alerting the Resident Engineer of any issues that they deem to constitute a potential contract change prior to acting on these issues.
  5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or Resident Engineer, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Agent.

### **1.3 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 21 08 00 COMMISSIONING OF FIRE PROTECTION SYSTEMS.
- C. Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.
- D. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- E. Section 26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS.
- F. Section 27 08 00 COMMISSIONING OF COMMUNICATIONS SYSTEMS.
- G. Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
- H. Section 31 08 00 COMMISSIONING OF UTILITIES.

**1.4 SUMMARY**

- A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.
- B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.
- C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the VA requirements developed for the project.
  - 1. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" and the prerequisite of "Fundamental Building Systems Commissioning."
  - 2. Activities and documentation for the LEED™ section on "Measurement and Verification" requirements for the Measurement and Verification credit.

**1.5 DEFINITIONS**

- A. Architect: Includes Architect identified in the Contract for Construction between the Department of Veterans Affairs and Contractor, plus consultant/design professionals responsible for design of fire suppression, plumbing, HVAC, controls for HVAC systems, electrical, communications, electronic safety and security, as well as other related systems.
- B. CxA: Commissioning Agent.
- C. Commissioning Plan: a document that is an overall plan that outlines the commissioning process, commissioning team responsibilities, schedule for commissioning activities, and commissioning documents.
- D. Commissioning Issue: a condition in the installation or function of a component, piece of equipment or system that affects the system operations, maintenance, and/or repair.
- E. Commissioning Observation: a condition in the installation or function of a component, piece of equipment or system that may not be in compliance with the Contract Documents, or may not be in compliance with the manufacturer's installation instruction, or may not be in compliance with generally accepted industry standards.
- F. Systems Functional Performance Test: a test, or tests, of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Systems Functional Performance Testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential

pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not Systems Functional Performance Testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while System Functional Performance Testing is verifying that the system has already been set up properly and is functioning in accordance with the Construction Documents. The Commissioning Agent develops the Systems Functional Performance Test Procedures in a sequential written form, coordinates, witnesses, and documents the actual testing. Systems Functional Performance Testing is performed by the Contractor. Systems Functional Performance Tests are performed after startups, control systems are complete and operational, TAB functions and Pre-Functional Checklists are complete.

- G. System: A system is defined as the entire set of components, equipment, and subsystems which must be coordinated to work together during normal operation to produce results for which the system is designed. For example, air conditioning supply air is only one component of an entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam supply, chilled water supply, refrigerant supply, hot water supply, controls and electrical service, etc. Another example of a system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of the fuel supply, combustion air, controls, steam, feedwater supply, condensate return and other related components.
- H. Pre-Functional Checklist: a list of items provided by the Commissioning Agent to the Contractor that require inspection and elementary component tests conducted to verify proper installation of equipment. Pre-Functional Checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some Pre-Functional Checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The term "Pre-Functional" refers to before Systems Functional Performance Testing. Pre-Functional Checklists augment and are combined with the manufacturer's startup checklist and the Contractor's Quality Control checklists.
- I. Seasonal Functional Performance Testing: a test or tests that are deferred until the system will experience conditions closer to their design conditions.
- J. VA: Includes the Contracting Officer, Resident Engineer, or other authorized representative of the Department of Veterans Affairs.
- K. TAB: Testing, Adjusting, and Balancing.

**1.6 SYSTEMS TO BE COMMISSIONED**

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.
- B. The following systems will be commissioned as part of this project:
  - 1. Fire Suppression (Division 21)
  - 2. Plumbing (Division 22)
  - 3. HVAC (Division 23)
  - 4. Electrical (Division 26)
  - 5. Communications (Division 27)
  - 6. Electronic Safety and Security (Division 28)
  - 7. Site Utility Systems (Division 31)

**1.7 COMMISSIONING TEAM**

- A. Members Appointed by Contractor:
  - 1. Contractor: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.
  - 2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the Department of Veterans Affairs (VA) and Commissioning Agent.
- B. Members Appointed by VA:
  - 1. Commissioning Agent: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The VA will engage the CxA under a separate contract.
  - 2. Representatives of the facility user and operation and maintenance personnel.
  - 3. Architect and engineering design professionals.

**1.8 VA'S COMMISSIONING RESPONSIBILITIES**

- A. Appoint an individual, company or firm to act as the Commissioning Agent.

- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
  - 1. Coordination meetings.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
  - 3. Testing meetings.
  - 4. Witness and assist in Systems Functional Performance Testing.
  - 5. Demonstration of operation of systems, subsystems, and equipment.
- C. Provide the Construction Documents, prepared by Architect and approved by VA, to the Commissioning Agent and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.

#### **1.9 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES**

- A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractor, and subcontractors.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.
- C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
  - 1. Participate in commissioning coordination meetings.
  - 2. Conduct operation and maintenance training sessions in accordance with approved training plans.
  - 3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
  - 4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
  - 5. Review and comment on commissioning documentation.
  - 6. Participate in meetings to coordinate Systems Functional Performance Testing.
  - 7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan.
  - 8. Provide information to the Commissioning Agent for developing commissioning plan.

9. Participate in training sessions for VA's operation and maintenance personnel.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

#### **1.10 COMMISSIONING AGENT'S RESPONSIBILITIES**

- A. Organize and lead the commissioning team.
- B. Prepare the commissioning plan. See Paragraph 1.11-A of this specification Section for further information.
- C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and comment on the ability to test and operate the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents.
- D. At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.
- E. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
- F. Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
- G. Prepare Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.
- H. Coordinate Systems Functional Performance Testing schedule with the Contractor.
- I. Witness selected systems startups.
- J. Verify selected Pre-Functional Checklists completed and submitted by the Contractor.

- K. Witness and document Systems Functional Performance Testing.
- L. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
- M. Review and comment on operation and maintenance (O&M) documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Paragraph 1.25, Section 01 00 00 GENERAL REQUIREMENTS.
- N. Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.
- O. Prepare commissioning Field Observation Reports.
- P. Prepare the Final Commissioning Report.
- Q. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal Systems Functional Performance Testing. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.
- R. Assemble the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

#### **1.11 COMMISSIONING DOCUMENTATION**

- A. Commissioning Agent's Certification(s): Commissioning Agent shall submit evidence of valid and current certification(s), as required in Section 1.1(G), to the Contracting Officer.
- B. Commissioning Plan: A document, prepared by Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
  - 2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
  - 3. Identification of systems and equipment to be commissioned.

4. Schedule of Commissioning Coordination meetings.
  5. Identification of items that must be completed before the next operation can proceed.
  6. Description of responsibilities of commissioning team members.
  7. Description of observations to be made.
  8. Description of requirements for operation and maintenance training.
  9. Schedule for commissioning activities with dates coordinated with overall construction schedule.
  10. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
  11. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
  12. Preliminary Systems Functional Performance Test procedures.
- C. Systems Functional Performance Test Procedures: The Commissioning Agent will develop Systems Functional Performance Test Procedures for each system to be commissioned, including subsystems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the VA, Architect/Engineer, and Contractor for review and comment. The Systems Performance Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
1. Name and identification code of tested system.
  2. Test number.
  3. Time and date of test.
  4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
  5. Dated signatures of the person performing test and of the witness, if applicable.
  6. Individuals present for test.
  7. Observations and Issues.
  8. Issue number, if any, generated as the result of test.
- D. Pre-Functional Checklists: The Commissioning Agent will prepare Pre-Functional Checklists. Pre-Functional Checklists shall be completed and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The Commissioning Agent will spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete



Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.

- E. Test and Inspection Reports: The Commissioning Agent will record test data, observations, and measurements on Systems Functional Performance Test Procedure. The report will also include recommendation for system acceptance or non-acceptance. Photographs, forms, and other means appropriate for the application shall be included with data. Commissioning Agent Will compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
- F. Corrective Action Documents: The Commissioning Agent will document corrective action taken for systems and equipment that fail tests. The documentation will include any required modifications to systems and equipment and/or revisions to test procedures, if any. The Commissioning Agent will witness and document any retesting of systems and/or equipment requiring corrective action and document retest results.
- G. Commissioning Issues Log: The Commissioning Agent will prepare and maintain Commissioning Issues Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. These observations and issues include, but are not limited to, those that are at variance with the Contract Documents. The Commissioning Issues Log will identify and track issues as they are encountered, the party responsible for resolution, progress toward resolution, and document how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved issues.
  - 1. Creating an Commissioning Issues Log Entry:
    - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
    - b. Assign a descriptive title for the issue.
    - c. Identify date and time of the issue.
    - d. Identify test number of test being performed at the time of the observation, if applicable, for cross reference.
    - e. Identify system, subsystem, and equipment to which the issue applies.
    - f. Identify location of system, subsystem, and equipment.
    - g. Include information that may be helpful in diagnosing or evaluating the issue.
    - h. Note recommended corrective action.
    - i. Identify commissioning team member responsible for corrective action.
    - j. Identify expected date of correction.
    - k. Identify person that identified the issue.
  - 2. Documenting Issue Resolution:
    - a. Log date correction is completed or the issue is resolved.

- b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
  - c. Identify changes to the Contract Documents that may require action.
  - d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
  - e. Identify person(s) who corrected or resolved the issue.
  - f. Identify person(s) verifying the issue resolution.
- H. Final Commissioning Report: The Commissioning Agent will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the Department of Veterans Affairs when determining that systems will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during VA occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:
  - 1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the Commissioning Agent.
  - 2. Commissioning plan.
- I. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot check.
  - 1. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
  - 2. Commissioning Issues Log.
  - 3. Listing of deferred and off season test(s) not performed, including the schedule for their completion.
- J. Addendum to Final Commissioning Report: The Commissioning Agent will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The Addendum will indicate whether systems, subsystems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:
  - 1. Documentation of deferred and off season test(s) results.
  - 2. Completed Systems Functional Performance Test Procedures for off season test(s).
  - 3. Documentation that unresolved system performance issues have been resolved.

4. Updated Commissioning Issues Log, including status of unresolved issues.
  5. Identification of potential Warranty Claims to be corrected by the Contractor.
- K. Systems Manual: The Commissioning Agent will gather required information and compile the Systems Manual. The Systems Manual will include, but is not limited to, the following:
1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.
  2. Reference to Final Commissioning Plan.
  3. Reference to Final Commissioning Report.
  4. Approved Operation and Maintenance Data as submitted by the Contractor.

#### **1.12 SUBMITTALS**

- A. Preliminary Commissioning Plan Submittal: The Commissioning Agent has prepared a Preliminary Commissioning Plan based on the final Construction Documents. The Preliminary Commissioning Plan is included as an Appendix to this specification section. The Preliminary Commissioning Plan is provided for information only. It contains preliminary information about the following commissioning activities:
1. The Commissioning Team: A list of commissioning team members by organization.
  2. Systems to be commissioned. A detailed list of systems to be commissioned for the project. This list also provides preliminary information on systems/equipment submittals to be reviewed by the Commissioning Agent; preliminary information on Pre-Functional Checklists that are to be completed; preliminary information on Systems Performance Testing, including information on testing sample size (where authorized by the VA).
  3. Commissioning Team Roles and Responsibilities: Preliminary roles and responsibilities for each Commissioning Team member.
  4. Commissioning Documents: A preliminary list of commissioning-related documents, include identification of the parties responsible for preparation, review, approval, and action on each document.
  5. Commissioning Activities Schedule: Identification of Commissioning Activities, including Systems Functional Testing, the expected duration and predecessors for the activity.
  6. Pre-Functional Checklists: Preliminary Pre-Functional Checklists for equipment, components, subsystems, and systems to be commissioned. These Preliminary Pre-Functional Checklists provide guidance on the level of detailed information the Contractor shall include on the final submission.

- B. Systems Functional Performance Test Procedures: Preliminary step-by-step System Functional Performance Test Procedures to be used during Systems Functional Performance Testing. These Preliminary Systems Functional Performance procedures provide information on the level of testing rigor, and the level of Contractor support required during performance of system's testing.
- C. Final Commissioning Plan Submittal: Based on the Final Construction Documents and the Contractor's project team, the Commissioning Agent will prepare the Final Commissioning Plan as described in this section. The Commissioning Agent will submit three hard copies and three sets of electronic files of Final Commissioning Plan. The Contractor shall review the Commissioning Plan and provide any comments to the VA. The Commissioning Agent will incorporate review comments into the Final Commissioning Plan as directed by the VA.
- D. Systems Functional Performance Test Procedure: The Commissioning Agent will submit preliminary Systems Functional Performance Test Procedures to the Contractor, and the VA for review and comment. The Contractor shall return review comments to the VA and the Commissioning Agent. The VA will also return review comments to the Commissioning Agent. The Commissioning Agent will incorporate review comments into the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing.
- E. Pre-Functional Checklists: The Commissioning Agent will submit Pre-Functional Checklists to be completed by the Contractor.
- F. Test and Inspection Reports: The Commissioning Agent will submit test and inspection reports to the VA with copies to the Contractor and the Architect/Engineer.
- G. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the VA Resident Engineer with copies to the Contractor and Architect.
- H. Preliminary Commissioning Report Submittal: The Commissioning Agent will submit three electronic copies of the preliminary commissioning report. One electronic copy, with review comments, will be returned to the Commissioning Agent for preparation of the final submittal.
- I. Final Commissioning Report Submittal: The Commissioning Agent will submit four sets of electronically formatted information of the final commissioning report to the VA. The final submittal will incorporate comments as directed by the VA.
- J. Data for Commissioning:
1. The Commissioning Agent will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
  2. The Commissioning Agent may request further documentation as is necessary for the commissioning process or to support other VA data collection requirements, including Construction Operations Building

Information Exchange (COBIE), Building Information Modeling (BIM), etc.

#### **1.13 COMMISSIONING PROCESS**

- A. The Commissioning Agent will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with the VA and the Contractor. As directed by the VA, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.
- B. Within 15 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.
- C. Within 15 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

#### **1.14 QUALITY ASSURANCE**

- A. Instructor Qualifications: Factory authorized service representatives shall be experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- B. Test Equipment Calibration: The Contractor shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments. Instruments shall have been calibrated within six months prior to use.

#### **1.15 COORDINATION**

- A. Management: The Commissioning Agent will coordinate the commissioning activities with the VA and Contractor. The Commissioning Agent will submit commissioning documents and information to the VA. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor will work with the Commissioning Agent and the VA to incorporate the commissioning activities into the construction

schedule. The Commissioning Agent will provide sufficient information on commissioning activities to allow the Contractor and the VA to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the VA.

- C. Initial Schedule of Commissioning Events: The Commissioning Agent will provide the initial schedule of primary commissioning events in the Commissioning Plan and at the commissioning coordination meetings. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the Commissioning Agent.
- D. Commissioning Coordinating Meetings: The Commissioning Agent will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- E. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

## **PART 2 - PRODUCTS**

### **2.1 TEST EQUIPMENT**

- A. The Contractor shall provide all standard and specialized testing equipment required to perform Systems Functional Performance Testing. Test equipment required for Systems Functional Performance Testing will be identified in the detailed System Functional Performance Test Procedure prepared by the Commissioning Agent.
- B. Data logging equipment and software required to test equipment shall be provided by the Contractor.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 oC (1.0 oF) and a resolution of + or - 0.1 oC (0.2 oF). Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be

calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

## **PART 3 - EXECUTION**

### **3.1     STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS**

- A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.
  - 1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.
    - a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.
    - b. The Commissioning Agent will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques.
  - 2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.
    - a. The Contractor shall develop the full startup plan by combining (or adding to) the checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual data and the field checkout sheets normally used by the Contractor. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
    - b. The full startup plan shall at a minimum consist of the following items:
      - 1) The Pre-Functional Checklists.
      - 2) The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
      - 3) The manufacturer's normally used field checkout sheets.
      - 4) The Commissioning Agent will submit the full startup plan to the VA and Contractor for review. Final approval will be by the VA.

- 5) The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.
3. Sensor and Actuator Calibration
    - a. All field installed temperature, relative humidity, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described in Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 specifications.
    - b. All procedures used shall be fully documented on the Pre-Functional Checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
  4. Execution of Equipment Startup
    - a. Four weeks prior to equipment startup, the Contractor shall schedule startup and checkout with the VA and Commissioning Agent. The performance of the startup and checkout shall be directed and executed by the Contractor.
    - b. The Commissioning Agent will observe the startup procedures for selected pieces of primary equipment.
    - c. The Contractor shall execute startup and provide the VA and Commissioning Agent with a signed and dated copy of the completed startup checklists, and contractor tests.
    - d. Only individuals that have direct knowledge and witnessed that a line item task on the Startup Checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

### **3.2 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP**

- A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the VA and the Commissioning Agent within two days of completion.
- B. The Commissioning Agent will review the report and submit comments to the VA. The Commissioning Agent will work with the Contractor to correct and verify deficiencies or uncompleted items. The Commissioning Agent will involve the VA and others as necessary. The Contractor shall correct all areas that are noncompliant or incomplete in the checklists in a timely manner, and shall notify the VA and Commissioning Agent as soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the Commissioning Agent will recommend approval of the checklists and startup of each system to the VA.
- C. The Contractor shall be responsible for resolution of deficiencies as directed the VA.



**3.3 PHASED COMMISSIONING**

- A. The project may require startup and initial checkout to be executed in phases. This phasing shall be planned and scheduled in a coordination meeting of the VA, Commissioning Agent, and the Contractor. Results will be added to the master construction schedule and the commissioning schedule.

**3.4 TRENDING AND ALARMS**

- A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems at intervals specified below.
- B. Alarms are a means to notify the system operator that abnormal conditions are present in the system. Alarms shall be structured into three tiers - Critical, Priority, and Maintenance.
1. Critical alarms are intended to be alarms that require the immediate attention of and action by the Operator. These alarms shall be displayed on the Operator Workstation in a popup style window that is graphically linked to the associated unit's graphical display. The popup style window shall be displayed on top of any active window within the screen, including non DDC system software.
  2. Priority level alarms are to be printed to a printer which is connected to the Operator's Work Station located within the engineer's office. Additionally Priority level alarms shall be able to be monitored and viewed through an active alarm application. Priority level alarms are alarms which shall require reaction from the operator or maintenance personnel within a normal work shift, and not immediate action.
  3. Maintenance alarms are intended to be minor issues which would require examination by maintenance personnel within the following shift. These alarms shall be generated in a scheduled report automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.
- C. The Contractor shall provide a wireless internet network in the building for use during controls programming, checkout, and commissioning. This network will allow project team members to more effectively program, view, manipulate and test control devices while being in the same room as the controlled device.
- D. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below and included with the Systems Functional Performance Test Procedures. Trending shall occur before, during and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the Resident Engineer and Commissioning Agent for review and analysis before, during dynamic operation, and after Systems Functional Performance

Testing. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:

1. Pre-testing, Testing, and Post-testing - Trend reports of trend logs and graphical trend plots are required as defined by the Commissioning Agent. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the Resident Engineer. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the Resident Engineer, prior to the execution of Systems Functional Performance Testing.
  2. Dynamic plotting - The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.
  3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.
- E. The Contractor shall provide the following information prior to Systems Functional Performance Testing. Any documentation that is modified after submission shall be recorded and resubmitted to the Resident Engineer and Commissioning Agent.
1. Point-to-Point checkout documentation;
  2. Sensor field calibration documentation including system name, sensor/point name, measured value, DDC value, and Correction Factor.
  3. A sensor calibration table listing the referencing the location of procedures to following in the O&M manuals, and the frequency at which calibration should be performed for all sensors, separated by system, subsystem, and type. The calibration requirements shall be submitted both in the O&M manuals and separately in a standalone document containing all sensors for inclusion in the commissioning documentation. The following table is a sample that can be used as a template for submission.

SYSTEM		
Sensor	Calibration Frequency	O&M Calibration Procedure Reference
Discharge air temperature	Once a year	Volume I Section D.3.aa
Discharge static pressure	Every 6 months	Volume II Section A.1.c

4. Loop tuning documentation and constants for each loop of the building systems. The documentation shall be submitted in outline or table separated by system, control type (e.g. heating valve temperature control); proportional, integral and derivative constants, interval (and bias if used) for each loop. The following table is a sample that can be used as a template for submission.

AIR HANDLING UNIT AHU-1				
Control Reference	Proportional Constant	Integral Constant	Derivative Constant	Interval
Heating Valve Output	1000	20	10	2 sec.

### 3.5 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
- C. Development of Systems Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the Commissioning Agent will develop specific Systems Functional Test Procedures to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the Commissioning Agent in developing the Systems Functional Performance Test procedures as requested by the Commissioning Agent i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the Commissioning Agent will provide a copy of the Systems Functional Performance Test procedures to the VA, the Architect/Engineer, and the Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.

- D. Purpose of Test Procedures: The purpose of each specific Systems Functional Performance Test is to verify and document compliance with the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.) The test procedure forms developed by the Commissioning Agent will include, but not be limited to, the following information:
1. System and equipment or component name(s)
  2. Equipment location and ID number
  3. Unique test ID number, and reference to unique Pre-Functional Checklists and startup documentation, and ID numbers for the piece of equipment.
  4. Date
  5. Project name
  6. Participating parties
  7. A copy of the specification section describing the test requirements
  8. A copy of the specific sequence of operations or other specified parameters being verified
  9. Formulas used in any calculations
  10. Required pretest field measurements
  11. Instructions for setting up the test.
  12. Special cautions, alarm limits, etc.
  13. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
  14. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
  15. A section for comments.
  16. Signatures and date block for the Commissioning Agent. A place for the Contractor to initial to signify attendance at the test.
- E. Test Methods: Systems Functional Performance Testing shall be achieved by manual testing (i.e. persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by standalone data loggers. The Contractor and Commissioning Agent shall determine which method is most appropriate for tests that do not have a method specified.
1. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, although timing the testing to experience actual conditions is encouraged wherever practical.
  2. Overwritten Values: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible.

Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
  4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
  5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout.
- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.
- G. Sampling: No sampling is allowed in completing Pre-Functional Checklists. Sampling is allowed for Systems Functional Performance Test Procedures execution. The Commissioning Agent will determine the sampling rate. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Agent may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with Systems Functional Performance Testing of the remaining units.
- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days notice to the Commissioning Agent and the VA regarding the completion

schedule for the Pre-Functional Checklists and startup of all equipment and systems. The Commissioning Agent will schedule Systems Functional Performance Tests with the Contractor and VA. The Commissioning Agent will witness and document the Systems Functional Performance Testing of systems. The Contractor shall execute the tests in accordance with the Systems Functional Performance Test Procedure.

- J. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The control system shall be sufficiently tested and approved by the Commissioning Agent and the VA before it is used to verify performance of other components or systems. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.
- K. Problem Solving: The Commissioning Agent will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

### **3.6 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS**

- A. Documentation: The Commissioning Agent will witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Agent for that purpose. Prior to testing, the Commissioning Agent will provide these forms to the VA and the Contractor for review and approval. The Contractor shall include the filled out forms with the O&M manual data.
- B. Nonconformance: The Commissioning Agent will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the VA on Commissioning Field Reports and/or the Commissioning Master Issues Log.
  - 1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.
  - 2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Agent shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the VA.
  - 3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the VA.

4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
  - a. The Commissioning Agent will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the VA. The Commissioning Agent will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the VA and the Commissioning Agent.
  - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.
5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
  - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.
  - b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
  - c. The Commissioning Agent will document the resolution process.
  - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the Commissioning Agent. The requirement for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.
  - e. Spec Writer Note: Verify that the following paragraph regarding cost of retesting is allowed for the specific project. Retain or delete the paragraph as necessary.
- C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the VA. In such case, the Contractor shall provide the VA with the following:

1. Within one week of notification from the VA, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
  2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
  3. The VA shall determine whether a replacement of all identical units or a repair is acceptable.
  4. Two examples of the proposed solution shall be installed by the Contractor and the VA shall be allowed to test the installations for up to one week, upon which the VA will decide whether to accept the solution.
  5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- E. Approval: The Commissioning Agent will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the Commissioning Agent and by the VA. The Commissioning Agent will evaluate each test and report to the VA using a standard form. The VA will give final approval on each test using the same form, and provide signed copies to the Commissioning Agent and the Contractor.

### **3.7 DEFERRED TESTING**

- A. Unforeseen Deferred Systems Functional Performance Tests: If any Systems Functional Performance Test cannot be completed due to the building structure, required occupancy condition or other conditions, execution of the Systems Functional Performance Testing may be delayed upon approval of the VA. These Systems Functional Performance Tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of the Contractor to conduct these unforeseen Deferred Systems Functional Performance Tests shall be negotiated between the VA and the Contractor.
- B. Deferred Seasonal Testing: Deferred Seasonal Systems Functional Performance Tests are those that must be deferred until weather conditions are closer to the systems design parameters. The Commissioning Agent will review systems parameters and recommend which Systems Functional Performance Tests should be deferred until weather conditions more closely match systems parameters. The Contractor shall review and comment on the proposed schedule for Deferred Seasonal Testing. The VA will review and approve the schedule for Deferred Seasonal Testing. Deferred Seasonal Systems Functional Performances Tests shall be witnessed and documented by the Commissioning Agent. Deferred Seasonal Systems Functional



Performance Tests shall be executed by the Contractor in accordance with these specifications.

### **3.8 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS**

- A. Training Preparation Conference: Before operation and maintenance training, the Commissioning Agent will convene a training preparation conference to include VA's Resident Engineer, VA's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of VA Operations and Maintenance personnel.
- B. The Contractor shall provide training and demonstration as required by other Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 sections. The Training and Demonstration shall include, but is not limited to, the following:
  - 1. Review the Contract Documents.
  - 2. Review installed systems, subsystems, and equipment.
  - 3. Review instructor qualifications.
  - 4. Review instructional methods and procedures.
  - 5. Review training module outlines and contents.
  - 6. Review course materials (including operation and maintenance manuals).
  - 7. Review and discuss locations and other facilities required for instruction.
  - 8. Review and finalize training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
  - 9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Training Module Submittals: The Contractor shall submit the following information to the VA and the Commissioning Agent:
  - 1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for VA's use.
  - 2. Qualification Data: Submit qualifications for facilitator and/or instructor.
  - 3. Attendance Record: For each training module, submit list of participants and length of instruction time.
  - 4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

5. Demonstration and Training Videotapes: Submit two copies within seven days of end of each training module.
  - a. Identification: On each copy, provide an applied label with the following information:
    - 1) Name of Project.
    - 2) Name and address of photographer
    - 3) Name of Contractor.
    - 4) Date videotape was recorded.
    - 5) Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

#### D. QUALITY ASSURANCE

1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
2. Instructor Qualifications: A factory authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

#### E. COORDINATION

1. Coordinate instruction schedule with VA's operations. Adjust schedule as required to minimize disrupting VA's operations.
2. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
3. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the VA.

#### F. INSTRUCTION PROGRAM

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
  - a. Fire protection systems, including fire alarm, fire pumps, and fire suppression systems.

- b. Intrusion detection systems.
  - c. Conveying systems, including elevators, wheelchair lifts, escalators, and automated materials handling systems.
  - d. Medical equipment, including medical gas equipment and piping.
  - e. Laboratory equipment, including laboratory air and vacuum equipment and piping.
  - f. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
  - g. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
  - h. HVAC systems, including air handling equipment, air distribution systems, and terminal equipment and devices.
  - i. Switchgear, transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
  - j. Packaged engine generators, including synchronizing switchgear/switchboards, and transfer switches.
  - k. Lighting equipment and controls.
  - l. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass evacuation, voice and data, and entertainment television equipment.
  - m. Site utilities including lift stations, condensate pumping and return systems, and storm water pumping systems.
- G. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:
- 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance and design criteria if Contractor is delegated design responsibility.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.
  - 2. Documentation: Review the following items in detail:
    - a. Emergency manuals.
    - b. Operations manuals.
    - c. Maintenance manuals.
    - d. Project Record Documents.

- e. Identification systems.
  - f. Warranties and bonds.
  - g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
- a. Instructions on meaning of warnings, trouble indications, and error messages.
  - b. Instructions on stopping.
  - c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside of normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
- a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures.
  - g. Instructions on stopping.
  - h. Normal shutdown instructions.
  - i. Operating procedures for emergencies.
  - j. Operating procedures for system, subsystem, or equipment failure.
  - k. Seasonal and weekend operating instructions.
  - l. Required sequences for electric or electronic systems.
  - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
  - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of cleaning agents and methods of cleaning detrimental to product.
  - d. Procedures for routine cleaning
  - e. Procedures for preventive maintenance.

- f. Procedures for routine maintenance.
    - g. Instruction on use of special tools.
  - 8. Repairs: Include the following:
    - a. Diagnosis instructions.
    - b. Repair instructions.
    - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    - d. Instructions for identifying parts and components.
    - e. Review of spare parts needed for operation and maintenance.
- H. Training Execution:
  - 1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
  - 2. Instruction:
    - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Department of Veterans Affairs for number of participants, instruction times, and location.
    - b. Instructor: Engage qualified instructors to instruct VA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
      - 1) The Commissioning Agent will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
      - 2) The VA will furnish an instructor to describe VA's operational philosophy.
      - 3) The VA will furnish the Contractor with names and positions of participants.
  - 3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the VA and the Commissioning Agent with at least seven days' advance notice.
  - 4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, or a written, performance-based test.
  - 5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.
- I. Demonstration and Training Recording:
  - 1. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each

training module, record each chart containing learning objective and lesson outline.

2. Video Format: Provide high quality color DVD color on standard size DVD disks.
3. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
4. Narration: Describe scenes on videotape by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

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**SECTION 02 41 00**

**DEMOLITION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies demolition and removal of buildings, portions of buildings, utilities, other structures and debris from trash dumps shown.

**1.2 RELATED WORK:**

- A. Demolition and removal of roads, walks, curbs, and on-grade slabs outside buildings to be demolished: Section 31 20 00, EARTH MOVING.
- B. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- C. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.
- E. Asbestos Removal: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- F. Lead Paint: Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
- G. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- H. Construction Waste Management: Section 017419 CONSTRUCTION WASTE MANAGEMENT.
- I. Infectious Control: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7, INFECTION PREVENTION MEASURES.

**1.3 PROTECTION:**

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations. Comply with requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES AND IMPROVEMENTS.

- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.
- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
  - 1. No wall or part of wall shall be permitted to fall outwardly from structures.
  - 2. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
  - 3. Wherever a cutting torch or other equipment that might cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
  - 4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center any damaged items shall be repaired or replaced as approved by the Resident Engineer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer's approval.
- H. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- I. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7 INFECTION PREVENTION MEASURES.

#### **1.4 UTILITY SERVICES:**

- A. Demolish and remove outside utility service lines shown to be removed.



- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 DEMOLITION:**

- A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
  - 1. As required for installation of new utility service lines.
  - 2. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.
- B. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- C. In removing buildings and structures of more than two stories, demolish work story by story starting at highest level and progressing down to third floor level. Demolition of first and second stories may proceed simultaneously.
- D. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500 mm (5 feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- E. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.

**3.2 CLEAN-UP:**

- A. On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer. Clean-up shall include off the Medical Center disposal of all items and materials not required to remain property of the Government as well as all debris and rubbish resulting from demolition operations.

**3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 02 82 13.13**

**GLOVEBAG ASBESTOS ABATEMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY OF THE WORK**

**A. CONTRACT DOCUMENTS AND RELATED REQUIREMENTS**

1. Drawings, general provisions of the contract, including general and supplementary conditions and other Division 01 specifications, shall apply to the work of this section. The contract documents show the work to be done under the contract and related requirements and conditions impacting the project. Related requirements and conditions include applicable codes and regulations, notices and permits, existing site conditions and restrictions on use of the site, requirements for partial owner occupancy during the work, coordination with other work and the phasing of the work. In the event the Asbestos Abatement Contractor (Contractor) discovers a conflict in the contract documents and/or requirements or codes, the conflict must be brought to the immediate attention of the Contracting Officer for resolution. Whenever there is a conflict or overlap in the requirements, the most stringent shall apply. Any actions taken by the Contractor without obtaining guidance from the Contracting Officer shall become the sole risk and responsibility of the Contractor. All cost incurred due to such action are also the responsibility of the Contractor.

**B. EXTENT OF WORK**

1. Below is a brief description of the estimated quantities of asbestos containing materials to be abated by the glovebag method. These quantities are for informational purposes only and are based on the best information available at the time of the specification preparation. The Contractor shall satisfy himself as the actual quantities to be abated. Nothing in this section may be interpreted as limiting the extent of work otherwise required by this contract and related documents.
2. Removal, clean-up and disposal of ACM piping and fittings and asbestos contaminated elements in an appropriate regulated area as shown on the Drawings.
  - a. Typically a white hard-pack magnesium silicate ACM pipe insulation was used within steam tunnels. This should also be assumed to be present, therefore notification to the BAAQMD will be required. If present, the provisions of SECTION 02 82 13.13 GLOVEBAG ASBESTOS ABATEMENT, will also be required.

**C. RELATED WORK**

1. Section 07 84 00; FIRESTOPPING.
2. Section 02 41 00; DEMOLITION.

3. Division 22; PLUMBING.
4. Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION / Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING / Section 23 05 11, COMMON WORK RESULTS FOR HVAC
5. Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION.
6. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING / Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING / Section 22 11 00, FACILITY WATER DISTRIBUTION / Section 22 13 00, FACILITY SANITARY SEWERAGE / Section 22 14 00, FACILITY STORM DRAINAGE / Section 23 11 23, FACILITY NATURAL-GAS PIPING.
7. Section 23 21 13, HYDRONIC PIPING / Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
8. Section 23 31 00, HVAC DUCTS AND CASINGS / Section 23 37 00, OUTLETS AND INLETS.

D. TASKS

1. The work tasks are summarized briefly as follows:
  - a. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, work-site preparations, emergency procedures arrangements, and standard operating procedures for glovebag asbestos abatement work.
  - b. Abatement activities including removal, clean-up and disposal of ACM waste, recordkeeping, security, monitoring, and inspections.
  - c. Cleaning and decontamination activities including final visual inspection, air monitoring and certification of decontamination.

E. ABATEMENT CONTRACTOR USE OF PREMISES

1. The Contractor and Contractor's personnel shall cooperate fully with the VA representative/consultant to facilitate efficient use of buildings and areas within buildings. The Contractor shall perform the work in accordance with the VA specifications, drawings, phasing plan and in compliance with any/all applicable Federal, State, and Local regulations and requirements.
2. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved pre-abatement work plan. Asbestos abatement drawings of partially occupied buildings will show the limits of regulated areas; the placement of decontamination facilities; the temporary location of bagged waste ACM; the path of transport to outside the building; and the temporary waste storage area for each building/regulated area. Any variation from the arrangements shown on drawings shall be secured in writing from the VA representative through the pre-abatement plan of action. The following limitations of use shall apply to existing facilities shown on drawings:

**1.2 VARIATIONS IN QUANTITY**

- A. The quantities and locations of ACM as indicated on the drawings and the extent of work included in this section are estimates which are limited

by the physical constraints imposed by occupancy of the buildings. Accordingly, minor variations (+/- 5%) in quantities of ACM within the regulated area are considered as having no impact on contract price and time requirements of this contract. Where additional work is required beyond the above variation, the Contractor shall provide unit prices for additional footage for newly discovered materials and those prices will be used for additional work under the contract.

### 1.3 STOP ASBESTOS REMOVAL

- A. If the Contracting Officer or their field representative presents a written Stop Asbestos Removal Order, the Abatement Contractor/Personnel shall immediately stop all asbestos removal and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activity until authorized to do so by the VA. A stop asbestos removal order may be issued at any time the VA determines abatement conditions/activities are not within specification requirements. Work stoppage will continue until conditions have been corrected to the satisfaction of the VA. Standby time and costs for corrective actions will be borne by the Contractor, including the industrial hygienist's time. The occurrence of any of the following events shall be reported immediately by the Contractor in writing to the VA representative and shall require the Contractor to immediately stop asbestos removal activities and initiate fiber reduction activities:

1.  $\geq 0.01$  f/cc outside a regulated area or  $>0.05$  f/cc inside a regulated area;
2. breach/break in regulated area critical barrier(s)/floor;
3. serious injury/death at the site;
4. fire/safety emergency at the site;
5. respiratory protection system failure;
6. power failure or loss of wetting agent; or
7. any visible emissions observed outside the regulated area.

### 1.4 DEFINITIONS

A. GENERAL

1. Definitions and explanations here are neither complete nor exclusive of all terms used in the contract documents, but are general for the work to the extent they are not stated more explicitly in another element of the contract documents. Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated therein.

B. GLOSSARY

1. **Abatement** - Procedures to control fiber release from asbestos-containing materials, typically during removal. Includes removal, encapsulation, enclosure, demolition and renovation activities related to asbestos.
2. **ACE** - Asbestos contaminated elements.
3. **ACM** - Asbestos containing material.

4. **Aerosol** - Solid or liquid particulate suspended in air.
5. **Adequately wet** - Sufficiently mixed or penetrated with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted.
6. **Aggressive method** - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.
7. **Aggressive sampling** - EPA AHERA defined clearance sampling method using air moving equipment such as fans and leaf blowers to aggressively disturb and maintain in the air residual fibers after abatement.
8. **AHERA** - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.
9. **Aircell** - Pipe or duct insulation made of corrugated cardboard which contains asbestos.
10. **Air monitoring** - The process of measuring the fiber content of a known volume of air collected over a specified period of time. The NIOSH 7400 Method, Issue 2 is used to determine the fiber levels in air.
11. **Air sample filter** - The filter used to collect fibers which are then counted. The filter is made of mixed cellulose ester membrane for PCM (Phase Contrast Microscopy) and polycarbonate for TEM (Transmission Electron Microscopy)
12. **Amended water** - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.
13. **Asbestos** - Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated or altered. Asbestos also includes PACM, as defined below.
14. **Asbestos-containing material (ACM)** - Any material containing more than one percent asbestos.
15. **Asbestos contaminated elements (ACE)** - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.
16. **Asbestos-containing waste material** - Asbestos-containing material or asbestos contaminated objects requiring disposal.
17. **Asbestos waste decontamination facility** - A system consisting of drum/bag washing facilities and a temporary storage area for cleaned containers of asbestos waste. Used as the exit for waste and equipment leaving the regulated area. In an emergency, it may be used to evacuate personnel.
18. **Authorized person** - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.
19. **Authorized visitor** - Any person approved by the VA; the contractor; or any government agency having jurisdiction over the regulated area.

20. **Barrier** - Any surface the isolates the regulated area and inhibits fiber migration from the regulated area.
21. **Containment Barrier** - An airtight barrier consisting of walls, floors, and/or ceilings of sealed plastic sheeting which surrounds and seals the outer perimeter of the regulated area.
22. **Critical Barrier** - The barrier responsible for isolating the regulated area from adjacent spaces, typically constructed of plastic sheeting secured in place at openings such as doors, windows, or any other opening into the regulated area.
23. **Primary Barrier** - Barriers placed over critical barriers and exposed directly to abatement work.
24. **Secondary Barrier** - Any additional sheeting used to isolate and provide protection from debris during abatement work.
25. **Breathing zone** - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.
26. **Bridging encapsulant** - An encapsulant that forms a layer on the surface of the ACM.
27. **Building/facility owner** - The legal entity, including a lessee, which exercises control over management and recordkeeping functions relating to a building and/or facility in which asbestos activities take place.
28. **Bulk testing** - The collection and analysis of suspect asbestos containing materials.
29. **Certified Industrial Hygienist (CIH)** - One certified in practice of industrial hygiene by the American Board of Industrial Hygiene. An industrial hygienist Certified in Comprehensive Practice by the American Board of Industrial Hygiene.
30. **Class I asbestos work** - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).
31. **Class II asbestos work** - Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic.
32. **Clean room/Changing room** - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.
33. **Clearance sample** - The final air sample taken after all asbestos work has been done and visually inspected. Performed by the VA's industrial hygiene consultant (VPIH/CIH).
34. **Closely resemble** - The major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.
35. **Competent person** - In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos

- exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor.
36. **Contractor's Professional Industrial Hygienist (CPIH)** - The Contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of the PIH.
  37. **Count** - Refers to the fiber count or the average number of fibers greater than five microns in length per cubic centimeter of air.
  38. **Decontamination area/unit** - An enclosed area adjacent to and connected to the regulated area and consisting of an equipment room, shower room, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.
  39. **Demolition** - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.
  40. **Disposal bag** - Typically 6 mil thick siftproof, dustproof, leaktight container used to package and transport asbestos waste from regulated areas to the approved landfill. Each bag/container must be labeled/marked in accordance with EPA, OSHA and DOT requirements.
  41. **Disturbance** - Activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM. Disturbance includes cutting away small amounts of ACM or PACM, no greater than the amount that can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or disposal bag which shall not exceed 60 inches in length or width.
  42. **Drum** - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be siftproof, dustproof, and leaktight.
  43. **Employee exposure** - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.
  44. **Encapsulant** - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.
  45. **Encapsulation** - Treating ACM with an encapsulant.
  46. **Enclosure** - The construction of an air tight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.
  47. **Equipment room** - A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.
  48. **Fiber** - A particulate form of asbestos, 5 microns or longer, with a length to width ratio of at least 3 to 1.
  49. **Fibers per cubic centimeter (f/cc)** - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.



50. **Filter** - Media used in respirators, vacuums, or other machines to remove particulate from air.
51. **Firestopping** - Material used to close the open parts of a structure in order to prevent a fire from spreading.
52. **Friable asbestos containing material** - Any material containing more than 1 percent asbestos as determined using the method specified in appendix A, Subpart F, 40 CFR 763, section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.
53. **Glovebag** - Not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which materials and tools may be handled.
54. **High efficiency particulate air (HEPA) filter** - A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 microns or greater in diameter.
55. **HEPA vacuum** - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.
56. **Homogeneous area** - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.
57. **HVAC** - Heating, Ventilation and Air Conditioning
58. **Industrial hygienist** - A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards. Meets definition requirements of the American Industrial Hygiene Association (AIHA).
59. **Industrial hygienist technician** - A person working under the direction of an IH or CIH who has special training, experience, certifications and licenses required for the industrial hygiene work assigned.
60. **Intact** - The ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.
61. **Lockdown** - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.
62. **National Emission Standards for Hazardous Air Pollutants (NESHAP's)** - EPA's rule to control emissions of asbestos to the environment.
63. **Negative initial exposure assessment** - A demonstration by the employer which complies with the criteria in 29 CFR 1926.1101 (f) (2) (iii), that employee exposure during an operation is expected to be consistently below the PEL's.
64. **Negative pressure** - Air pressure which is lower than the surrounding area, created by exhausting air from a sealed regulated area through HEPA equipped filtration units. OSHA requires maintaining -0.02" water gauge inside the negative pressure enclosure.

- 65. **Negative pressure respirator** - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air outside the respirator.
- 66. **Non-friable ACM** - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.
- 67. **Organic vapor cartridge** - The type of cartridge used on air purifying respirators for organic vapor exposures.
- 68. **Outside air** - The air outside buildings and structures, including, but not limited to, the air under a bridge or in an open ferry dock.
- 69. **Owner/operator** - Any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.
- 70. **Penetrating encapsulant** - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.
- 71. **Personal sampling/monitoring** - Representative air samples obtained in the breathing zone of the person using a cassette and battery operated pump to determine asbestos exposure.
- 72. **Permissible exposure limit (PEL)** - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the PEL is 0.1 fibers per cc.
- 73. **Polarized light microscopy (PLM)** - Light microscopy using dispersion staining techniques and refractive indices to identify and quantify the type(s) of asbestos present in a bulk sample.
- 74. **Polyethylene sheeting** - Strong plastic barrier material 4 to 6 mils thick, semi-transparent, sometimes flame retardant in compliance with NFPA 241.
- 75. **Positive/negative fit check** - A method of verifying the fit of a respirator by closing off the filters and breathing in or closing off the exhalation valve and breathing out while detecting leakage of the respirator.
- 76. **Presumed ACM (PACM)** - Thermal system insulation, surfacing, and flooring material installed in buildings prior to 1981. If the building owner has actual knowledge, or should have known through the exercise of due diligence that other materials are ACM, they too must be treated as PACM. The designation of PACM may be rebutted pursuant to 29 CFR 1926.1101 (k) (5).
- 77. **Professional IH** - An IH who meets the definition requirements of AIHA; meets the definition requirements of OSHA as a "Competent Person" at 29 CFR 1926.1101 (b); has completed two specialized EPA approved courses on management and supervision of asbestos abatement projects; has formal training in respiratory protection and waste disposal; and has a minimum of four projects of similar complexity with this project of which at least three projects serving as the supervisory IH.
- 78. **Project designer** - A person who has successfully completed the training requirements for an asbestos abatement project designer as required by 40 CFR 763 Appendix C, Part I; (B) (5).

- 79. **Protection factor** - A value assigned by OSHA/NIOSH to indicate the assigned protection a respirator should provide if worn properly. The number indicates the reduction of exposure level from outside to inside the respirator.
- 80. **Qualitative fit test (QLFT)** - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.
- 81. **Quantitative fit test (QNFT)** - A fit test using a challenge material which is quantified outside and inside the respirator thus allowing the determination of the actual fit factor.
- 82. **Regulated area** - An area established by the employer to demarcate where Class I, II, III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work may accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed the PEL.
- 83. **Regulated ACM (RACM)** - Friable ACM; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of the demolition or renovation operation.
- 84. **Removal** - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.
- 85. **Renovation** - Altering a facility or one or more facility components in any way, including the stripping or removal of asbestos from a facility component which does not involve demolition activity.
- 86. **Repair** - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.
- 87. **Shower room** - The portion of the PDF where personnel shower before leaving the regulated area. Also used for bag/drum decontamination in the EDF.
- 88. **Standard operating procedures (SOP's)** - Asbestos work procedures required to be submitted by the contractor before work begins.
- 89. **Supplied air respirator (SAR)** - A respirator that utilizes an air supply separate from the air in the regulated area.
- 90. **Surfacing ACM** - A material containing more than 1 percent asbestos that is sprayed, troweled on or otherwise applied to surfaces for acoustical, fireproofing and other purposes.
- 91. **Surfactant** - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.
- 92. **Thermal system ACM** - A material containing more than 1 percent asbestos applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.
- 93. **Transmission electron microscopy (TEM)** - A microscopy method that can identify and count asbestos fibers.

94. **VA Industrial Hygienist (VPIH/CIH)** - Department of Veterans Affairs Professional Industrial Hygienist.
95. **VA Representative** - The VA official responsible for on-going project work.
96. **Visible emissions** - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM or ACM waste material.
97. **Waste generator** - Any owner or operator whose act or process produces asbestos-containing waste material.
98. **Waste/Equipment decontamination facility (W/EDF)** - The area in which equipment is decontaminated before removal from the regulated area.
99. **Waste shipment record** - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.
100. **Wet cleaning** - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

C. REFERENCED STANDARDS ORGANIZATIONS

1. The following acronyms or abbreviations as referenced in contract/specification documents are defined to mean the associated names. Names and addresses may be subject to change.
  - a. VA Department of Veterans Affairs  
810 Vermont Avenue, NW  
Washington, DC 20420
  - b. AIHA American Industrial Hygiene Association  
2700 Prosperity Avenue, Suite 250  
Fairfax, VA 22031  
703-849-8888
  - c. ANSI American National Standards Institute  
1430 Broadway  
New York, NY 10018  
212-354-3300
  - d. ASTM American Society for Testing and Materials  
1916 Race St.  
Philadelphia, PA 19103  
215-299-5400
  - e. CFR Code of Federal Regulations  
Government Printing Office  
Washington, DC 20420
  - f. CGA Compressed Gas Association  
1235 Jefferson Davis Highway  
Arlington, VA 22202  
703-979-0900
  - g. CS Commercial Standard of the National Institute of Standards and Technology (NIST)
  - h. U. S. Department of Commerce  
Government Printing Office  
Washington, DC 20420

- i. EPA Environmental Protection Agency  
401 M St., SW  
Washington, DC 20460  
202-382-3949
- j. MIL-STD Military Standards/Standardization Division  
Office of the Assistant Secretary of Defense  
Washington, DC 20420
- k. MSHA Mine Safety and Health Administration  
Respiratory Protection Division  
Ballston Tower #3  
Department of Labor  
Arlington, VA 22203  
703-235-1452
- l. NIST National Institute for Standards and Technology
- m. U. S. Department of Commerce  
Gaithersburg, MD 20234  
301-921-1000
- n. NEC National Electrical Code (by NFPA)
- o. NEMA National Electrical Manufacturer's Association  
2101 L Street, NW  
Washington, DC 20037
- p. NFPA National Fire Protection Association  
1 Batterymarch Park  
P.O. Box 9101  
Quincy, MA 02269-9101  
800-344-3555
- q. NIOSH National Institutes for Occupational Safety and Health  
4676 Columbia Parkway  
Cincinnati, OH 45226  
513-533-8236
- r. OSHA Occupational Safety and Health Administration
- s. U.S. Department of Labor  
Government Printing Office  
Washington, DC 20402
- t. UL Underwriters Laboratory  
333 Pfingsten Rd.  
Northbrook, IL 60062  
312-272-8800
- u. USA United States Army  
Army Chemical Corps  
Department of Defense  
Washington, DC 20420

## **1.5 APPLICABLE CODES AND REGULATIONS**

### **A. GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS**

1. All work under this contract shall be done in strict accordance with all applicable Federal, State, and local regulations, standards and codes governing asbestos abatement, and any other trade work done in conjunction with the abatement. All applicable codes, regulations and standards are adopted into this specification and will have the same

force and effect as this specification.

2. The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specification exists, the most stringent requirement(s) shall be utilized.
3. Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed in Section 1.5 shall be available at the worksite in the clean change area of the worker decontamination system.

B. CONTRACTOR RESPONSIBILITY

1. The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State and Local regulations related to any and all aspects of the abatement project. The contractor is responsible for providing and maintaining training, accreditation, medical exams, medical records, personal protective equipment as required by applicable Federal, State and Local regulations. The contractor shall hold the VA and VPIH/CIH consultants harmless for any failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of himself, his employees, or his subcontractors. The contractor will incur all costs of the CPIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements.

C. FEDERAL REQUIREMENTS

1. Federal requirements which govern some aspect of asbestos abatement include, but are not limited to, the following regulations.
  - a. Occupational Safety and Health Administration (**OSHA**)
    - 1) Title 29 CFR 1926.1101 - Construction Standard for Asbestos
    - 2) Title 29 CFR 1910.132 - Personal Protective Equipment
    - 3) Title 29 CFR 1910.134 - Respiratory Protection
    - 4) Title 29 CFR 1926 - Construction Industry Standards
    - 5) Title 29 CFR 1910.20 - Access to Employee Exposure and Medical Records
    - 6) Title 29 CFR 1910.1200 - Hazard Communication
    - 7) Title 29 CFR 1910.151 - Medical and First Aid
  - b. Environmental Protection Agency (**EPA**)
    - 1) 40 CFR 61 Subpart A and M (Revised Subpart B) - National Emission Standard for Hazardous Air Pollutants - Asbestos.
    - 2) 40 CFR 763.80 - Asbestos Hazard Emergency Response Act (AHERA)
  - c. Department of Transportation (**DOT**)
    - 1) Title 49 CFR 100 - 185 - Transportation

D. STATE REQUIREMENTS:

1. State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:
  - a. California OSHA regulations: 8 CCR 1529 (Asbestos)
  - b. California OSHA regulations: 8 CCR 5144 (Respiratory compliance)
  - c. California Waste Regulations: Title 22

E. LOCAL REQUIREMENTS

1. If local requirements are more stringent than federal or state standards, the local standards are to be followed.
  - a. Bay Area Air Quality Management District (Regulation 11, Rule 2)

F. STANDARDS

1. Standards which govern asbestos abatement activities include, but are not limited to, the following:
  - a. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems Z88.2 - Practices for Respiratory Protection.
  - b. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA filter Units, 7th Edition.
2. Standards which govern encapsulation work include, but are not limited to, the following:
  - a. American Society for Testing and Materials (ASTM)
3. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:
  - a. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
  - b. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.
  - c. NFPA 101 - Life Safety Code

G. EPA GUIDANCE DOCUMENTS

1. EPA guidance documents which discuss asbestos abatement work activities are listed below. These documents are made part of this section by reference. EPA publications can be ordered from (800) 424-9065.
2. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024
3. Asbestos Waste Management Guidance EPA 530-SW-85-007.
4. A Guide to Respiratory Protection for the Asbestos Abatement Industry EPA-560-OPTS-86-001
5. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

H. NOTICES

1. State and Local agencies: Send written notification as required by state and local regulations including the local fire department prior to beginning any work on ACM as follows:
2. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification is given to EPA, State, and Local authorities.

I. PERMITS/LICENSES

1. The contractor shall apply for and have all required permits and licenses to perform asbestos abatement work as required by Federal, State, and Local regulations.

J. POSTING AND FILING OF REGULATIONS

1. Maintain two (2) copies of applicable federal, state, and local regulations. Post one copy of each at the regulated area where workers will have daily access to the regulations and keep another copy in the Contractor's office.

K. VA RESPONSIBILITIES

1. Prior to commencement of work:
  - a. Notify occupants adjacent to regulated areas of project dates and requirements for relocation, if needed. Arrangements must be made prior to starting work for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the regulated area. **Note: Notification of adjacent personnel is required by OSHA in 29 CFR 1926.1101 (k) to prevent unnecessary or unauthorized access to the regulated area.**
  - b. Submit to the Contractor results of background air sampling; including location of samples, person who collected the samples, equipment utilized and method of analysis.
  - c. During abatement, submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. This information shall not release the Contractor from any responsibility for OSHA compliance.

L. SITE SECURITY

1. Regulated area access is to be restricted only to authorized, trained/accredited and protected personnel. These may include the Contractor's employees, employees of Subcontractors, VA employees and representatives, State and local inspectors, and any other designated individuals. A list of authorized personnel shall be established prior to commencing the project and be posted in the clean room of the decontamination unit.
2. Entry into the regulated area by unauthorized individuals shall be reported immediately to the Competent Person by anyone observing the entry. The Competent Person shall immediately notify the VA.
3. A log book shall be maintained in the clean room of the decontamination unit. Anyone who enters the regulated area must record their name, affiliation, time in, and time out for each entry.



4. Access to the regulated area shall be through a single decontamination unit, if required. All other access (doors, windows, hallways, etc.) shall be sealed or locked to prevent entry to or exit from the regulated area. The only exceptions for this requirement are the waste/equipment load-out area which shall be sealed except during the removal of containerized asbestos waste from the regulated area, and emergency exits. Emergency exits shall not be locked from the inside, however, they shall be sealed with poly sheeting and taped until needed.
5. The Contractor's Competent Person shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel. A 24 hour security system shall be provided at the entrance to the regulated area to assure that all entrants are logged in/out and that only authorized personnel are allowed entrance.
6. The Abatement Contractor will have the VA's assistance in notifying adjacent personnel of the presence, location and quantity of ACM in the regulated area and enforcement of restricted access by the VA's employees.
7. The regulated area shall be locked during non-working hours and secured by VA security guards.

M. EMERGENCY ACTION PLAN AND ARRANGEMENTS

1. An Emergency Action Plan shall be developed by the Contractor prior to commencing abatement activities and shall be agreed to by the Contractor and the VA. The Plan shall meet the requirements of 29 CFR 1910.38 (a); (b).
2. Emergency procedures shall be in written form and prominently posted and available in the regulated area. Everyone, prior to entering the regulated area, must read and sign these procedures to acknowledge understanding of the regulated area layout, location of emergency exits and emergency procedures.
3. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule and layout of regulated area, particularly barriers that may affect response capabilities.
4. Emergency planning shall include consideration of fire, explosion, hazardous atmospheres, electrical hazards, slips/trips and falls, confined spaces, and heat stress illness. Written procedures for response to emergency situations shall be developed and employee training in procedures shall be provided.
5. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
  - a. For non life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers, if necessary, before exiting the regulated area to obtain proper medical treatment.
  - b. For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured

worker, remove them from the regulated area, and secure proper medical treatment.

6. Telephone numbers of all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
7. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3 minutes of a life-threatening injury/illness. Bloodborne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.
8. The Emergency Action Plan shall provide for a Contingency Plan in the event that an incident occurs that may require the modification of the standard operating procedures during abatement. Such incidents include, but are not limited to, fire; accident; and power failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that work is stopped and wetting is continued until correction of the problem.

N. PRE-CONSTRUCTION MEETING

1. Prior to commencing the work, the Contractor shall meet with the VPCIH to present and review, as appropriate, the items following this paragraph. The Contractor's Competent Person(s) who will be on-site shall participate in the pre-start meeting. The pre-start meeting is to discuss and determine procedures to be used during the project. At this meeting, the Contractor shall provide:
  - a. Proof of Contractor licensing.
  - b. Proof the Competent Person is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person shall also be presented.
  - c. A list of all workers who will participate in the project, including experience and verification of training and accreditation.
  - d. A list of and verification of training for all personnel who have current first-aid/CPR training. A minimum of one person per shift must have adequate training.
  - e. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
  - f. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
  - g. A copy of the Contractor's Standard Operating Procedures for Class I Glovebag Asbestos Abatement. In these procedures, the following information must be detailed, specific for this project.
    - 1) Regulated area preparation procedures;
    - 2) Notification requirements procedure of Contractor as required in 29 CFR 1926.1101 (d);
    - 3) If required, decontamination area set-up/layout and decontamination procedures for employees;
    - 4) Glovebag abatement methods/procedures and equipment to be used;

- 5) Personal protective equipment to be used;
- h. At this meeting the Contractor shall provide all submittals as required.
- i. Procedures for handling, packaging and disposal of asbestos waste.
- j. Emergency Action Plan and Contingency Plan Procedures.

#### **1.6 PROJECT COORDINATION**

- A. The following are the minimum administrative and supervisory personnel necessary for coordination of the work.

##### **1. PERSONNEL**

- a. Administrative and supervisory personnel shall consist of a qualified Competent Person as defined by OSHA in the Construction Standards and the Asbestos Construction Standard; Contractor Professional Industrial Hygienist and Industrial Hygiene Technicians. These employees are the Contractor's representatives responsible for compliance with these specifications and all other applicable requirements.
- b. Non-supervisory personnel shall consist of an adequate number of qualified personnel to meet the schedule requirements of the project. Personnel shall meet required qualifications. Personnel utilized on-site shall be pre-approved by the VA representative. A request for approval shall be submitted for any person to be employed during the project giving the person's name; social security number; qualifications; accreditation card with picture; Certificate of Worker's Acknowledgment; and Affidavit of Medical Surveillance and Respiratory Protection and current Respirator Fit Test.
- c. Minimum qualifications for Contractor and assigned personnel are:
  - 1) The Contractor has conducted within the last three (3) years, three (3) projects of similar complexity and dollar value as this project; has not been cited and penalized for serious violations of asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work; is licensed in applicable states; has adequate and qualified personnel available to complete the work; has comprehensive standard operating procedures for asbestos work; has adequate materials, equipment and supplies to perform the work.
  - 2) The Competent Person has four (4) years of abatement experience of which two (2) years were as the Competent Person on the project; meets the OSHA definition of a Competent Person; has been the Competent Person on two (2) projects of similar size and complexity as this project; has completed EPA AHERA/OSHA/State/Local training requirements/accreditation(s) and refreshers; and has all required OSHA documentation related to medical and respiratory protection.
  - 3) The Contractor Professional Industrial Hygienist (CPIH) shall have five (5) years of monitoring experience and

supervision of asbestos abatement projects; has participated as senior IH on five (5) abatement projects, three (3) of which are similar in size and complexity as this project; has developed at least one complete standard operating procedure for asbestos abatement; has trained abatement personnel for three (3) years; has specialized EPA AHERA/OSHA training in asbestos abatement management, respiratory protection, waste disposal and asbestos inspection; has completed the NIOSH 582 Course, Contractor/Supervisor course; and has appropriate medical/respiratory protection records/documentation.

- 4) The Abatement Personnel shall have completed the EPA AHERA/OSHA abatement worker course; have training on the standard operating procedures of the Contractor; has one year of asbestos abatement experience; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

## **1.7 RESPIRATORY PROTECTION**

### **A. GENERAL - RESPIRATORY PROTECTION PROGRAM**

1. The Contractor shall develop and implement a Respiratory Protection Program (RPP) which is in compliance with the January 8, 1998 OSHA requirements found at 29 CFR 1926.1101 and 29 CFR 1910.132;134. ANSI Standard Z88.2-1992 provides excellent guidance for developing a respiratory protection program All respirators used must be NIOSH approved for asbestos abatement activities. The written respiratory protection shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c) (1) (i - ix) - Respiratory Protection Program.

### **B. RESPIRATORY PROTECTION PROGRAM COORDINATOR**

1. The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years experience coordinating the program. The RPPC must provide a signed statement attesting to the fact that the program meets the above requirements.

### **C. SELECTION AND USE OF RESPIRATORS**

1. The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualification. The procedure must be written clearly enough for workers to understand. A copy of the Respiratory Protection Program must be available in the clean room of the decontamination unit for reference by employees or authorized visitors.

### **D. MINIMUM RESPIRATORY PROTECTION**

1. Minimum respiratory protection shall be a full face powered air purifying respirator when fiber levels are maintained consistently at or below 0.5 f/cc. A higher level of respiratory protection may be provided or required, depending on fiber levels. Respirator selection shall meet the requirements of 29 CFR 1926.1101 (h); Table 1, except as indicated in this paragraph. Abatement personnel must

have a respirator for their exclusive use.

E. MEDICAL WRITTEN OPINION

1. No employee shall be allowed to wear a respirator unless a physician has determined they are capable of doing so and has issued a written opinion for that person.

F. RESPIRATOR FIT TEST

1. All personnel wearing respirators shall have a current quantitative fit test which was conducted in accordance with 29 CFR 1910.134 (f) and Appendix A. Fit tests shall be done for PAPR's which have been put into a failure mode.

G. RESPIRATOR FIT CHECK

1. The Competent Person shall assure that the positive/negative fit check is done each time the respirator is donned by an employee. Headcoverings must cover respirator headstraps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a fit check shall preclude that person from wearing a respirator until resolution of the problem.

H. MAINTENANCE AND CARE OF RESPIRATORS

1. The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) maintenance and care of respirators.

**1.8 WORKER PROTECTION**

A. TRAINING OF ABATEMENT PERSONNEL

1. Prior to beginning any abatement activity, all personnel shall be trained in accordance with OSHA 29 CFR 1926.1101 (k) (9) and any additional State/Local requirements. Training must include, at a minimum, the elements listed at 29 CFR 1926.1101 (k) (9) (viii). Training shall have been conducted by a third party, EPA/State approved trainer meeting the requirements of EPA 40 CFR 763 Appendix C (AHERA MAP). Initial training certificates and current refresher and accreditation proof must be submitted for each person working at the site.

B. MEDICAL EXAMINATIONS

1. Medical examinations meeting the requirements of 29 CFR 1926.1101 (m) shall be provided for all personnel working in the regulated area, regardless of exposure levels. The physician's written opinion as required by 29 CFR 1926.1101 (m) (4) shall be provided for each person and shall include in the opinion the person has been evaluated for working in a heat stress environment while wearing personal protective equipment and is able to perform the work.

C. PERSONAL PROTECTIVE EQUIPMENT

1. Provide whole body clothing, head coverings, foot coverings and any other personal protective equipment as determined by conducting

the hazard assessment required by OSHA at 29 CFR 1910.132 (d). The Competent Person shall ensure the integrity of personal protective equipment worn for the duration of the project. Duct tape shall be used to secure all suit sleeves to wrists and to secure foot coverings at the ankle.

D. REGULATED AREA ENTRY PROCEDURE

1. Worker protection shall meet the most stringent requirement. The Competent Person shall ensure that each time workers enter the regulated area, they remove ALL street clothes in the clean room of the decontamination unit and put on new disposable coveralls, head coverings, a clean respirator, and then proceed through the shower room to the equipment room where they put on non-disposable required personal protective equipment.

E. DECONTAMINATION PROCEDURE - PAPR

1. The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area.
2. When exiting the regulated area, remove disposable coveralls, and ALL other clothes, disposable head coverings, and foot coverings or boots in the equipment room.
3. Still wearing the respirator and completely naked, proceed to the shower. Showering is MANDATORY. Care must be taken to follow reasonable procedures in removing the respirator to avoid asbestos fibers while showering. The following procedure is required as a minimum:
  - a. Thoroughly wet body including hair and face. If using a PAPR hold blower above head to keep filters dry.
  - b. With respirator still in place, thoroughly decontaminate body, hair, respirator face piece, and all other parts of the respirator except the blower and battery pack on a PAPR. Pay particular attention to cleaning the seal between the face and respirator facepiece and under the respirator straps.
  - c. Take a deep breath, hold it and/or exhale slowly, completely wetting hair, face, and respirator. While still holding breath, remove the respirator and hold it away from the face before starting to breathe.
4. Carefully decontaminate the facepiece of the respirator inside and out. If using a PAPR, shut down using the following sequence: a) first cap inlets to filters; b) turn blower off to keep debris collected on the inlet side of the filter from dislodging and contaminating the outside of the unit; c) thoroughly decontaminate blower and hoses; d) carefully decontaminate battery pack with a wet rag being cautious of getting water in the battery pack thus preventing destruction. **THIS PROCEDURE IS NOT A SUBSTITUTE FOR RESPIRATOR CLEANING!**
5. Shower and wash body completely with soap and water. Rinse thoroughly.
6. Rinse shower room walls and floor to drain prior to exiting.
7. Proceed from shower to clean room; dry off and change into street clothes or into new disposable work clothing.

F. REGULATED AREA REQUIREMENTS

1. The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for Class I glovebag regulated areas at 29 CFR 1926.1101 (e) are met. All personnel in the regulated area shall not be allowed to eat, drink, smoke, chew tobacco or gum, apply cosmetics, or in any way interfere with the fit of their respirator.

**1.9 DECONTAMINATION FACILITIES**

A. DESCRIPTION

1. Provide each regulated area with separate personnel (PDF) and waste/equipment decontamination facilities (W/EDF). Ensure that the PDF is the only means of ingress and egress to the regulated area and that all equipment, bagged waste, and other material exit the regulated area only through the W/EDF.

B. GENERAL REQUIREMENTS

1. All personnel entering or exiting a regulated area shall follow the requirements at 29 CFR 1926.1101 (j) (1) and these specifications. All equipment and materials must exit the regulated area through the W/EDF and be decontaminated in accordance with these specifications. Walls and ceilings of the PDF and W/EDF must be constructed of a minimum of 3 layers of 6 mil opaque fire retardant polyethylene sheeting and be securely attached to existing building components and/or an adequate temporary framework. A minimum of 3 layers of 6 mil poly shall also be used to cover the floor under the PDF and W/EDF units. Construct doors so that they overlap and secure to adjacent surfaces. Weigh sheets with layers of duct tape so that they close quickly after release. Put arrows on sheets so they show direction of travel and overlap. If the building adjacent area is occupied, construct a solid barrier on the occupied side(s) to protect the sheeting.
2. NOTE: OSHA does not require a decontamination area/unit if less than 25 linear feet of glove bagging is done.

C. TEMPORARY FACILITIES TO THE PDF and w/EDF

1. The Competent Person shall provide temporary water service connections to the PDF and W/EDF. Backflow prevention must be provided at the point of connection to the VA system. Water supply must be of adequate pressure and meet requirements of 29 CFR 1910.141(d) (3). Provide adequate temporary electric power with ground fault protection and overhead wiring in the PDF and W/EDF. Provide a sub-panel for all temporary power in the clean room. Provide adequate lighting to provide a minimum of 50 foot candles in the PDF and W/EDF. Provide temporary heat to maintain 70°F throughout the PDF and W/EDF..

D. PERSONNEL DECONTAMINATION FACILITY (PDF)

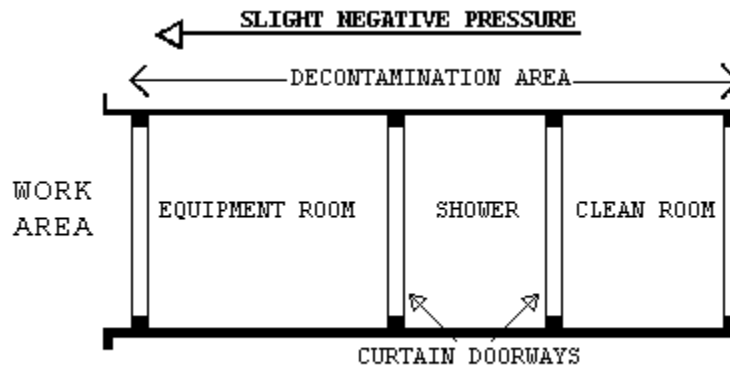
1. The Competent Person shall provide a PDF consisting of shower room which is contiguous to a clean room and equipment room. The PDF must be sized to accommodate the number of personnel scheduled for the project. The shower room, located in the center of the PDF, shall be

- fitted with as many portable showers as necessary to insure all employees can complete the entire decontamination procedure within 15 minutes. The PDF shall be constructed of opaque poly for privacy. The PDF shall be constructed to eliminate any parallel routes of egress without showering.
2. **Clean Room:** The clean room must be physically and visually separated from the rest of the building to protect the privacy of personnel changing clothes. The clean room shall be constructed of at least 2 layers of 6 mil fire retardant poly to provide an air tight room. Provide a minimum of 2 - 900 mm (3 foot) wide flapped doorways. One doorway shall be the entry from outside the PDF and the second doorway shall be to the shower room of the PDF. The floor of the clean room shall be maintained in a clean, dry condition. Shower overflow shall not be allowed into the clean room. An adequate supply of disposable towels shall be provided. Provide storage lockers per person. A portable fire extinguisher, Type ABC, shall be provided in accordance with OSHA and NFPA Standard 10. All persons entering the regulated area shall remove all street clothing in the clean room and dress in disposable protective clothing and respiratory protection. Any person entering the clean room does so either from the outside with street clothing on or is coming from the shower room completely naked and thoroughly washed. Females required to enter the regulated area shall be ensured of their privacy throughout the entry/exit process by posting guards at both entry points to the PDF so no male can enter or exit the PDF during her stay in the PDF.
  3. **Shower Room:** The Competent Person shall assure that the shower room is a completely water tight compartment to be used for the movement of all personnel from the clean room to the equipment room and for the showering of all personnel going from the regulated area to the clean room. Each shower shall be constructed so water runs down the walls of the shower and into a drip pan. Install a freely draining smooth floor on top of the shower pan. The shower room shall be separated from the rest of the building and from the clean room and equipment room using air tight walls made from at least 3 layers of 6 mil fire retardant poly. The shower shall be equipped with a shower head and controls, hot and cold water, drainage, soap dish and continuous supply of soap, and shall be maintained in a sanitary condition throughout its use. The controls shall be arranged so an individual can shower without assistance. Provide a flexible hose shower head, hose bibs and all other items shown on Shower Schematic. Waste water will be pumped to a drain after being filtered through a minimum of a 100 micron sock in the shower drain; a 20 micron filter; and a final 5 micron filter. Filters will be changed a minimum of daily or more often as needed. Filter changes must be done in the shower to prevent loss of contaminated water. Hose down all shower surfaces after each shift and clean any debris from the shower pan. Residue is to be disposed of as asbestos waste.
  4. **Equipment Room:** The Competent Person shall provide an equipment room which shall be an air tight compartment for the storage of work equipment, reusable footwear and for use as a change station for personnel exiting the regulated area. The equipment room shall be separated from the regulated area by a minimum 3 foot wide door made of 2 layers of 6 mil fire retardant poly. The equipment room shall



be separated from the regulated area, the shower room and the rest of the building by air tight walls and ceiling constructed of a minimum of 3 layers of 6 mil fire retardant poly. Damp wipe all surfaces of the equipment room after each shift change. Provide an additional loose layer of 6 mil fire retardant poly per shift change and remove this layer after each shift. Provide a temporary electrical sub-panel equipped with GFCI in this room to accommodate any equipment required in the regulated area.

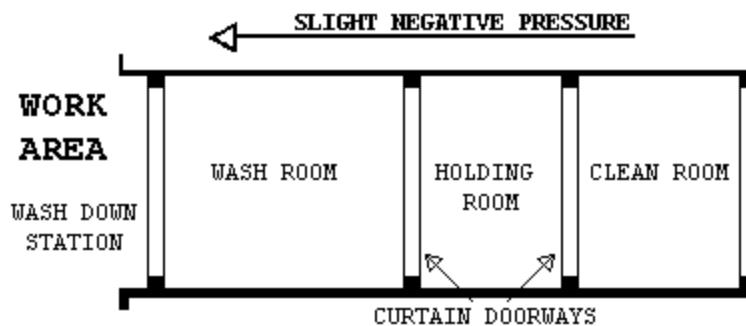
5. The PDF shall consist of the following: Clean room at the entrance followed by a shower room followed by an equipment room leading to the regulated area. Each doorway in the PDF is minimum of 2 layers of 6 mil fire retardant poly.



E. WASTE/EQUIPMENT DECONTAMINATION FACILITY (W/EDF)

1. The Competent Person shall provide a W/EDF consisting of a wash room, holding room, and clean room for removal of all waste, equipment and contaminated material from the regulated area. Personnel shall not enter or exit the W/EDF except in the event of an emergency. Clean debris and residue in the W/EDF daily. All surfaces in the W/EDF shall be wiped/hosed down after each shift and all debris shall be cleaned from the shower pan. The W/EDF shall consist of the following:
  - a. Wash Down Station: Provide an enclosed shower unit in the regulated area just outside the Wash Room as an equipment, bag and container cleaning station.
  - b. Wash Room: Provide a wash room for cleaning of bagged or containerized asbestos containing waste materials passed from the regulated area. Construct the wash room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. Locate the wash room so that packaged materials, after being wiped clean, can be passed to the Holding Room. Doorways in the wash room shall be constructed of 2 layers of 6 mil fire retardant poly.
  - c. Holding Room: Provide a holding room as a drop location for bagged materials passed from the wash room. Construct the holding room using 50 x 100 mm (2" x 4") wood framing and 3 layers of 6 mil fire retardant poly. The holding room shall be located so that bagged material cannot be passed from the wash room to the clean

- room unless it goes through the holding room. Doorways in the holding room shall be constructed of 2 layers of 6 mil fire retardant poly.
- d. Clean Room: Provide a clean room to isolate the holding room from the building exterior. Construct the clean room using 2 x 4 wood framing and 2 layers of 6 mil fire retardant poly. The clean room shall be located so as to provide access to the holding room from the building exterior. Doorways to the clean room shall be constructed of two layers of 6 mil fire retardant poly.
  - e. The W/EDF shall be provided as follows: Wash Room leading to a Holding Room followed by a Clean Room leading to outside the regulated area. See diagram.



#### F. WASTE/EQUIPMENT DECONTAMINATION PROCEDURES

1. At washdown station in the regulated area, thoroughly wet clean contaminated equipment and/or sealed polyethylene bags and pass into Wash Room after visual inspection. When passing anything into the Wash Room, close all doorways of the W/EDF, other than the doorway between the washdown station and the Wash Room. Keep all outside personnel clear of the W/EDF. Once inside the Wash Room, wet clean the equipment and/or bags. After cleaning and inspection, pass items into the Holding Room. Close all doorways except the doorway between the Holding Room and the Clean Room. Workers from the Clean Room/Exterior shall enter the Holding Room and remove the decontaminated/cleaned equipment/bags for removal and disposal. These personnel will not be required to wear PPE. At no time shall personnel from the clean side be allowed to enter the Wash Room.

## PART 2 - PRODUCTS, MATERIALS AND EQUIPMENT

### 2.1 MATERIALS AND EQUIPMENT

#### A. GENERAL REQUIREMENTS (all abatement projects)

1. Prior to the start of work, the Contractor shall provide and maintain a sufficient quantity of materials and equipment to assure continuous and efficient work throughout the duration of the project. Work shall not start unless the following items have been delivered to the site

and the CPIH has submitted verification to the VA's representative to this effect:

- a. All materials shall be delivered in their original package, container or bundle bearing the name of the manufacturer and the brand name (where applicable).
- b. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Flammable materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated/work area until abatement is completed.
- c. The Contractor shall not block or hinder use of buildings by patients, staff, and visitors to the VA in partially occupied buildings by placing materials/equipment in any unauthorized place.
- d. The Competent Person shall inspect for damaged, deteriorating or previously used materials. Such materials shall not be used and shall be removed from the worksite and disposed of properly.
- e. Poly sheeting put under the glovebag regulated area shall be a minimum of 6 mils in thickness.
- f. If required, the method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and the VA and selected to minimize damage to equipment and surfaces.
- g. Polyethylene sheeting utilized for personnel decontamination facility shall be opaque white or black in color, 6 mil fire retardant poly.
- h. Installation and plumbing hardware, showers, hoses, drain pans, sump pumps and waste water filtration system shall be provided by the Contractor.
- i. An adequate number of HEPA vacuums, scrapers, sprayers, nylon brushes, brooms, disposable mops, rags, sponges, staple guns, shovels, ladders and scaffolding of suitable height and length as well as meeting OSHA requirements shall be provided. Fall protection devices, water hose to reach all areas in the regulated area, airless spray equipment, and any other tools, materials or equipment required to conduct the abatement project shall also be provided. All electrically operated hand tools, equipment, electric cords shall be equipped with GFCI protection.
- j. Special protection for objects in the regulated area shall be detailed (e.g., plywood over carpeting or hardwood floors to prevent damage from scaffolds, water, and falling material).
- k. Disposal bags - 2 layers of 6 mil, for asbestos waste shall be pre-printed with labels, markings and address as required by OSHA, EPA and DOT regulations.
- l. The VA shall be provided a copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication. Chlorinated compounds shall not be used with any spray adhesive or other product. Appropriate encapsulant(s) shall be provided.
- m. OSHA DANGER demarcation signs, as many and as required by OSHA 29 CFR 1926.1101(k) (7) shall be provided and placed by the Competent Person. All other posters and notices required by Federal and State regulations shall be posted in the Clean Room.

- n. Adequate and appropriate PPE for the project and number of personnel/shifts shall be provided. All personal protective equipment issued must be based on a hazard assessment conducted under 29 CFR 1910.132(d).

## **2.2 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA**

### **A. GENERAL**

- 1. Using critical barriers, seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All horizontal surfaces in the regulated area must be covered with 2 layers of 6 mil fire retardant poly to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated, immediately stop work and clean up the contamination at no additional cost to the Government. Provide firestopping and identify all fire barrier penetrations due to abatement work as specified in Section 2.2.8; FIRESTOPPING.

### **B. PREPARATION PRIOR TO SEALING THE REGULATED AREA**

- 1. Place all tools, scaffolding, materials and equipment needed for working in the regulated area prior to erecting any plastic sheeting. Remove all uncontaminated removable furniture, equipment and/or supplies from the regulated area before commencing work, or completely cover with 2 layers of 6-mil fire retardant poly sheeting and secure with duct tape. Lock out and tag out any HVAC systems in the regulated area.

### **C. CONTROLLING ACCESS TO THE REGULATED AREA**

- 1. Access to the regulated area is allowed only through the personnel decontamination facility (PDF), if required. All other means of access shall be eliminated and OSHA Danger demarcation signs posted as required by OSHA. If the regulated area is adjacent to or within view of an occupied area, provide a visual barrier of 6 mil opaque fire retardant poly sheeting to prevent building occupant observation. If the adjacent area is accessible to the public, the barrier must be solid.

### **D. CRITICAL BARRIERS**

- 1. Completely separate any openings into the regulated area from adjacent areas using fire retardant poly at least 6 mils thick and duct tape. Individually seal with 2 layers of 6 mil poly and duct tape all HVAC openings into the regulated area. Individually seal all lighting fixtures, clocks, doors, windows, convectors, speakers, or any other objects in the regulated area. Heat must be shut off any objects covered with poly.

### **E. SECONDARY BARRIERS**

- 1. A loose layer of 6 mil fire retardant poly shall be used as a drop cloth to protect the floor/horizontal surfaces from debris generated during the glovebag abatement. This layer shall be replaced as needed during the work.

F. EXTENSION OF THE REGULATED AREA

1. If the enclosure of the regulated area is breached in any way that could allow contamination to occur, the affected area shall be included in the regulated area and constructed as per this section. If the affected area cannot be added to the regulated area, decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

G. FIRESTOPPING

1. Through penetrations caused by cables, cable trays, pipes, sleeves must be firestopped with a fire-rated firestop system providing an air tight seal.
2. Firestop materials that are not equal to the wall or ceiling penetrated shall be brought to the attention of the VA Representative. The Contractor shall list all areas of penetration, the type of sealant used, and whether or not the location is fire rated. Any discovery of penetrations during abatement shall be brought to the attention of the VA Representative immediately. All walls, floors and ceilings are considered fire rated unless otherwise determined by the VA Representative or Fire Marshall.
3. Any visible openings whether or not caused by a penetration shall be reported by the Contractor to the VA Representative for a sealant system determination. Firestops shall meet ASTM E814 and UL 1479 requirements for the opening size, penetrant, and fire rating needed.

**2.3 MONITORING, INSPECTION AND TESTING**

A. GENERAL

1. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. The CPIH shall periodically inspect and oversee the performance of the Contractor IH Technician. The IH Technician shall continuously inspect and monitor conditions inside the regulated area to ensure compliance with these specifications. In addition, the CPIH shall personally manage air sample collection, analysis, and evaluation for personnel, regulated area, and adjacent area samples to satisfy OSHA requirements. Additional inspection and testing requirements are also indicated in other parts of this specification.
2. The VA will employ an independent industrial hygienist (VPIH/CIH) consultant and/or use its own IH to perform various services on behalf of the VA. The VPIH/CIH will perform the necessary monitoring, inspection, testing, and other support services to ensure that VA patients, employees, and visitors will not be adversely affected by the abatement work, and that the abatement work proceeds in accordance with these specifications, that the abated areas or abated buildings have been successfully decontaminated. The work of the VPIH/CIH consultant in no way relieves the Contractor from their responsibility to perform the work in accordance with contract/specification requirements, to perform continuous inspection, monitoring and testing for the safety of their employees, and to perform other such services as specified. The cost of the VPIH/CIH and their services

will be borne by the VA except for any repeat of final inspection and testing that may be required due to unsatisfactory initial results. Any repeated final inspections and/or testing, if required, will be paid for by the Contractor.

3. If fibers counted by the VPIH/CIH during abatement work, either inside or outside the regulated area, utilizing the NIOSH 7400 air monitoring method, exceed the specified respective limits, the Contractor shall stop work. The Contractor may request confirmation of the results by analysis of the samples by TEM. Request must be in writing and submitted to the VA's representative. Cost for the confirmation of results will be borne by the Contractor for both the collection and analysis of samples and for the time delay that may/does result for this confirmation. Confirmation sampling and analysis will be the responsibility of the CPIH with review and approval of the VPIH/CIH. An agreement between the CPIH and the VPIH/CIH shall be reached on the exact details of the confirmation effort, in writing, including such things as the number of samples, location, collection, quality control on-site, analytical laboratory, interpretation of results and any follow-up actions. This written agreement shall be co-signed by the IH's and delivered to the VA's representative.

B. SCOPE OF SERVICES OF THE VPIH/cih CONSULTANT

1. The purpose of the work of the VPIH/CIH is to: Assure quality; resolve problems; and prevent the spread of contamination beyond the regulated area. In addition, their work includes performing the final inspection and testing to determine whether the regulated area or building has been adequately decontaminated. All air monitoring is to be done utilizing PCM/TEM. The VPIH/CIH will perform the following tasks:
  - a. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
  - b. Task 2: Perform continuous air monitoring, inspection, and testing outside the regulated area during actual abatement work to detect any faults in the regulated area isolation and any adverse impact on the surroundings from regulated area activities.
  - c. Task 3: Perform unannounced visits to spot check overall compliance of work with contract/specifications. These visits may include any inspection, monitoring, and testing inside and outside the regulated area and all aspects of the operation except personnel monitoring.
  - d. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of unforeseen developments, etc.
  - e. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area or building at the conclusion of the abatement and clean-up work to certify compliance with all regulations and the VA requirements/specifications.
  - f. Task 6: Issue certificate of decontamination for each regulated area or building and project report.
2. All data, inspection results and testing results generated by the

VPIH/CIH will be available to the Contractor for information and consideration. The Contractor shall cooperate with and support the VPIH/CIH for efficient and smooth performance of their work.

3. The monitoring and inspection results of the VPIH/CIH will be used by the VA to issue any Stop Removal orders to the Contractor during abatement work and to accept or reject a regulated area or building as decontaminated.

C. MONITORING, INSPECTION AND TESTING BY ABATEMENT CONTRACTOR CPIH

1. The CPIH is responsible for managing all monitoring, inspections, and testing required by these specifications, as well as any and all regulatory requirements adopted by these specifications. The CPIH is responsible for the continuous monitoring of all subsystems and procedures which could affect the health and safety of the Contractor's personnel. Safety and health conditions and the provision of those conditions inside the regulated area for all persons entering the regulated area is the exclusive responsibility of the Contractor /Competent Person. The person performing the personnel and area air monitoring inside the regulated area shall be an IH Technician, who shall be trained and shall have specialized field experience in air sampling and analysis. The IH Technician shall have a NIOSH 582 Course or equivalent and show proof. The IH Technician shall participate in the AIHA Asbestos Analysis Registry or participate in the Proficiency Analytic Testing program of AIHA for fiber counting quality control assurance. The IH Technician shall also be an accredited EPA/State Contractor/Supervisor and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation. The analytic laboratory used by the Contractor to analyze the samples shall be AIHA accredited for asbestos PAT. A daily log documenting all OSHA requirements for air monitoring for asbestos in 29 CFR 1926.1101(f), (g) and Appendix A. This log shall be made available to the VA representative and the VPIH/CIH. The log will contain, at a minimum, information on personnel or area sampled, other persons represented by the sample, the date of sample collection, start and stop times for sampling, sample volume, flow rate, and fibers/cc. The CPIH shall collect and analyze samples for each representative job being done in the regulated area, i.e., removal, wetting, clean-up, and load-out. No fewer than two personal samples per shift shall be collected and one area sample per 1,000 square feet of regulated area where abatement is taking place and one sample per shift in the clean room area shall be collected. In addition to the continuous monitoring required, the CPIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH responsibilities.

## 2.4 STANDARD OPERATING PROCEDURES

- A. The Contractor shall have established Standard Operating Procedures (SOP's) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the ways and procedures to be followed during all phases of the work by the Contractor's personnel. The SOP's must be modified as needed to address specific requirements of the project. The SOP's shall be submitted for

review and approval prior to the start of any abatement work. The minimum topics and areas to be covered by the SOP's are:

1. Minimum Personnel Qualifications
2. Contingency Plans and Arrangements
3. Security and Safety Procedures
4. Respiratory Protection/Personal Protective Equipment Program and Training
5. Medical Surveillance Program and Recordkeeping
6. Regulated Area Requirements for Glovebag Abatement
7. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
8. Monitoring, Inspections, and Testing
9. Removal Procedures For Piping ACM Using the Glovebag Method
10. Disposal of ACM waste
11. Regulated Area Decontamination/Clean-up
12. Regulated Area Visual and Air Clearance
13. Project Completion/Closeout

## **2.5 SUBMITTALS**

### **A. PRE-CONSTRUCTION MEETING SUBMITTALS**

1. Submit to the VA a minimum of 14 days prior to the pre-start meeting the following for review and approval. Meeting this requirement is a prerequisite for the pre-start meeting for this project.
  - a. Submit a detailed work schedule for the entire project reflecting contract documents and the phasing/schedule requirements from the CPM chart.
  - b. Submit a staff organization chart showing all personnel who will be working on the project and their capacity/function. Provide their qualifications, training, accreditations, and licenses, as appropriate. Provide a copy of the "Certificate of Worker's Acknowledgment" and the "Affidavit of Medical Surveillance and Respiratory Protection" for each person.
  - c. Submit Standard Operating Procedures developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH.
  - d. Submit the specifics of the materials and equipment to be used for this project with brand names, model numbers, performance characteristics, pictures/diagrams, and number available for the following:
    - 1) HEPA vacuums, air monitoring pumps, calibration devices, and emergency power generating system.
    - 2) Waste water filtration system, shower system, critical/floor barriers.
    - 3) Encapsulants, surfactants, hand held sprayers, airless sprayers, glovebags, fire extinguishers.



- 4) Personal protective equipment.
  - 5) Fire safety equipment to be used in the regulated area.
  - e. Submit the name, location, and phone number of the approved landfill; proof/verification the landfill is approved for ACM disposal; the landfill's requirements for ACM waste; the type of vehicle to be used for transportation; and name, address, and phone number of subcontractor, if used. Proof of asbestos training for transportation personnel shall be provided.
  - f. Submit required notifications and arrangements made with regulatory agencies having regulatory jurisdiction and the specific contingency/emergency arrangements made with local health, fire, ambulance, hospital authorities and any other notifications/arrangements.
  - g. Submit the name, location and verification of the laboratory and/or personnel to be used for analysis of air and/or bulk samples. Air monitoring must be done in accordance with OSHA 29 CFR 1926.1101(f) and Appendix A.
  - h. Submit qualifications verification: Submit the following evidence of qualifications. Make sure that all references are current and verifiable by providing current phone numbers and documentation.
    - 1) Asbestos Abatement Company: Project experience within the past 3 years; listing projects first most similar to this project: Project Name; Type of Abatement; Duration; Cost; Reference Name/Phone Number; Final Clearance; Completion Date
    - 2) List of project(s) halted by owner, A/E, IH, regulatory agency in the last 3 years: Project Name; Reason; Date; Reference Name/Number; Resolution
    - 3) List asbestos regulatory citations, penalties, damages paid and legal actions taken against the company in the last 3 years. Provide copies and all information needed for verification.
2. Submit information on personnel: Provide a resume; address each item completely; provide references; phone numbers; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH stating that all personnel submitted below have medical records in accordance with OSHA 29 CFR 1926.1101(m) and 29 CFR 1910.20 and that the company has implemented a medical surveillance program and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
- a. CPIH: Name; years of abatement experience; list of projects similar to this one; certificates, licenses, accreditations for proof of AHERA/OSHA specialized asbestos training; professional affiliations; number of workers trained; samples of training materials; samples of SOP's developed; medical opinion; current respirator fit test.
  - b. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person /Supervisor; list of similar projects as Competent Person/Supervisor; as a worker; certificates, licenses,

- accreditations; proof of AHERA/OSHA specialized asbestos training; maximum number of personnel supervised on a project; medical opinion; current respirator fit test.
- c. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses in asbestos abatement and respiratory protection; medical opinion; current respirator fit test.
- 3. Submit copies of State license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain english the coverage provided and the fact that asbestos abatement activities are covered by the policy; copy of SOP's incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who does and how is air monitoring conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; copies of monitoring results of the five referenced projects listed and analytical method(s) used.
- 4. When rental equipment is to be used in regulated areas or used to transport asbestos waste, the contractor shall assure complete decontamination of the rental equipment before return to the rental agency.
  - a. Submit, before the start of work, the manufacturer's technical data and MSDS for encapsulants used on the project. Provide application instructions also.

B. SUBMITTALS DURING ABATEMENT

- 1. The Competent Person shall maintain and submit a daily log at the regulated area documenting the dates and times of the following: purpose, attendees and summary of meetings; all personnel entering/exiting the regulated area; document and discuss the resolution of unusual events such as critical barrier breeching, equipment failures, emergencies, and any cause for stopping work; representative air monitoring and results/TWA's/EL's. Submit this daily log to VA's representative.
- 2. The CPIH shall document and maintain the following during abatement and submit as appropriate to the VA's representative.
  - a. Inspection and approval of the regulated area preparation prior to start of work and daily during work.
  - b. Removal of any poly critical/floor barriers.
  - c. Visual inspection/testing by the CPIH prior to application of lockdown encapsulation.
  - d. Packaging and removal of ACM waste from regulated area.
  - e. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

C. SUBMITTALS AT COMPLETION OF ABATEMENT

- 1. The CPIH shall submit a project report consisting of the daily log book requirements and documentation of events during the abatement

project including Waste Shipment Records signed by the landfill's agent. The report shall include a certificate of completion, signed and dated by the CPIH, in accordance with Attachment #1. The VA Representative will forward the abatement report to the Medical Center after completion of the project.

## **2.6      ENCAPSULANTS**

### **A.      TYPES OF ENCAPSULANTS**

1.    The following four types of encapsulants must comply with performance requirements as stated in paragraph 2.6.2:
  - a.    Removal encapsulant - used as a wetting agent to remove ACM.
  - b.    Bridging encapsulant - provides a tough, durable coating on ACM.
  - c.    Penetrating encapsulant - penetrates/encapsulates ACM at least 13 mm (1/2").
  - d.    Lockdown encapsulant - seals microscopic fibers on surfaces after ACM removal.

### **B.      PERFORMANCE REQUIREMENTS:    Encapsulants shall meet the latest requirements of EPA; shall not contain toxic or hazardous substances; or solvents; and shall comply with the following performance requirements:**

1.    General Requirements for all Encapsulants:
  - a.    ASTM E84: Flame spread of 25; smoke emission of 50.
  - b.    University of Pittsburgh Protocol: Combustion Toxicity; zero mortality.
  - c.    ASTM C732: Accelerated Aging Test; Life Expectancy - 20 years.
  - d.    ASTM E96: Permeability - minimum of 0.4 perms.
2.    Bridging/Penetrating Encapsulants:
  - a.    ASTM E736: Cohesion/Adhesion Test - 24 kPa (50 lbs/ft<sup>2</sup>).
  - b.    ASTM E119: Fire Resistance - 3 hours (Classified by UL for use on fibrous/cementitious fireproofing).
  - c.    ASTM D2794: Gardner Impact Test; Impact Resistance - minimum 11.5 kg-mm (43 in/lb).
  - d.    ASTM D522: Mandrel Bend Test; Flexibility - no rupture or cracking.
3.    Lockdown Encapsulants:
  - a.    ASTM E119: Fire resistance - 3 hours (tested with fireproofing over encapsulant applied directly to steel member).
  - b.    ASTM E736: Bond Strength - 48 kPa (100 lbs/ft<sup>2</sup>) (test compatibility with cementitious and fibrous fireproofing).
  - c.    In certain situations, encapsulants may have to be applied to hot pipes/equipment. The encapsulant must be able to withstand high temperatures without cracking or off-gassing any noxious vapors during application.

## **2.7 CERTIFICATES OF COMPLIANCE**

- A. The Contractor shall submit to the VA representative certification from the manufacturer indicating compliance with performance requirements for encapsulants when applied according to manufacturer recommendations.

## **2.8 RECYCLABLE PROTECTIVE CLOTHING**

- A. If recyclable clothing is provided, all requirements of EPA, DOT and OSHA shall be met.

# **PART 3 - EXECUTION**

## **3.1 PRE-ABATEMENT ACTIVITIES**

### **A. PRE-ABATEMENT MEETING**

- 1. The VA representative, upon receipt, review, and substantial approval of all pre-abatement submittals and verification by the CPIH that all materials and equipment required for the project are on the site, will arrange for a pre-abatement meeting between the Contractor, the CPIH, Competent Person(s), the VA representative(s), and the VPIH/CIH. The purpose of the meeting is to discuss any aspect of the submittals needing clarification or amplification and to discuss any aspect of the project execution and the sequence of the operation. The Contractor shall be prepared to provide any supplemental information/documentation to the VA's representative regarding any submittals, documentation, materials or equipment. Upon satisfactory resolution of any outstanding issues, the VA's representative will issue a written order to proceed to the Contractor. No abatement work of any kind described in the following provisions shall be initiated prior to the VA written order to proceed.

### **B. PRE-ABATEMENT INSPECTIONS AND PREPARATIONS:** Before any work begins on the construction of the regulated area, the Contractor will:

- 1. Conduct a space-by-space inspection with an authorized VA representative and prepare a written inventory of all existing damage in those spaces where asbestos abatement will occur. Still or video photography may be used to supplement the written damage inventory. Document will be signed and certified as accurate by both parties.
- 2. The VA Representative, the Contractor, and the VPIH/CIH must be aware of 10/95 A/E Quality Alert indicating the failure to identify asbestos as applicable to glovebag abatement in the areas listed. Make sure these areas are looked at/reviewed on the project: Lay-in ceilings concealing ACM; ACM behind walls/windows from previous renovations; inside chases/walls; transite piping/ductwork/sheets; behind radiators; below window sills; water/sewer lines; electrical conduit coverings; steam line trench coverings.
- 3. Ensure that all furniture, machinery, equipment, curtains, drapes, blinds, and other movable objects which the Contractor is required to remove from the regulated area have been cleaned and removed or properly protected from contamination.

4. Shut down and seal with a minimum of 2 layers of 6 mil fire retardant poly all HVAC systems serving the regulated area. The regulated area critical barriers shall be completely isolated from any other air in the building. The VA's representative will monitor the isolation provision.
5. Shut down and lock out in accordance with 29 CFR 1910.147 all electrical circuits which pose a potential hazard. Electrical arrangements will be tailored to the particular regulated area and the systems involved. All electrical circuits affected will be turned off at the circuit box outside the regulated area, not just the wall switch. The goal is to eliminate the potential for electrical shock which is a major threat to life in the regulated area due to water use and possible energized circuits. Electrical lines used to power equipment in the regulated area shall conform to all electrical safety standards and shall be isolated by the use of a ground fault circuit interrupter (GFCI). All GFCI shall be tested prior to use. The VA's representative will monitor the electrical shutdown.
6. If required, remove and dispose of carpeting from floors in the regulated area.
7. Inspect existing firestopping in the regulated area. Correct as needed.

C. PRE-ABATEMENT CONSTRUCTION AND OPERATIONS

1. Perform all preparatory work for the first regulated area in accordance with the approved work schedule and with this specification.
2. Upon completion of all preparatory work, the CPIH will inspect the work and systems and will notify the VA's representative when the work is completed in accordance with this specification. The VA's representative may inspect the regulated area and the systems with the VPIH/CIH and may require that upon satisfactory inspection, the Contractor's employees perform all major aspects of the approved SOP's, especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation.
3. The CPIH shall document the pre-abatement activities described above and deliver a copy to the VA's representative.
4. Upon satisfactory inspection of the installation of and operation of systems the VA's representative will notify the Contractor in writing to proceed with the asbestos abatement work in accordance with this specification.

**3.2 REGULATED AREA PREPARATIONS**

A. OSHA DANGER SIGNS

1. Post OSHA DANGER signs meeting the specifications of OSHA 29 CFR 1926.1101 at any location and approaches to the regulated area where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the regulated area to permit any personnel to read the sign and take the necessary measures to avoid exposure. Additional signs

will be posted following construction of the regulated area enclosure.

B. SHUT DOWN - LOCK OUT ELECTRICAL

1. Shut down and lock out electric power to the regulated area. Provide temporary power and lighting. Insure safe installation including GFCI of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.

C. SHUT DOWN - LOCK OUT HVAC

1. Shut down and lock out heating, cooling, and air conditioning system (**HVAC**) components that are in, supply or pass through the regulated area.
2. Investigate the regulated area and agree on pre-abatement condition with the VA's representative. Seal all intake and exhaust vents in the regulated area with duct tape and 2 layers of 6-mil poly. Also, seal any seams in system components that pass through the regulated area. Remove all contaminated HVAC system filters and place in labeled 6-mil poly disposal bags for disposal as asbestos waste.

D. SANITARY FACILITIES

1. The Contractor shall provide sanitary facilities for abatement personnel and maintain them in a clean and sanitary condition throughout the abatement project.

E. WATER FOR ABATEMENT

1. The VA will provide water for abatement purposes. The Contractor shall connect to the existing VA system. The service to the shower(s) shall be supplied with backflow prevention.

F. PRE-CLEANING MOVABLE OBJECTS

1. Pre-clean all movable objects within the regulated area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the regulated area and carefully stored in an uncontaminated location.

G. PRE-CLEANING FIXED OBJECTS

1. Pre-clean all fixed objects in the regulated area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Also, pay particular attention to wall, floor and ceiling penetration behind fixed items. After precleaning, enclose fixed objects with 2 layers of 6-mil poly and seal securely in place with duct tape. Objects (e.g., permanent fixtures, shelves, electronic equipment, laboratory tables, sprinklers, alarm systems, closed circuit TV equipment and computer cables) which must remain in the regulated area and that require special ventilation or enclosure requirements should be designated here along with specified means of protection. Contact the manufacturer for special protection requirements.

H. PRE-CLEANING SURFACES IN THE REGULATED AREA

1. Pre-clean all surfaces in the regulated area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos-containing materials during this pre-cleaning phase.

**3.3 CONTAINMENT BARRIERS AND COVERINGS FOR THE REGULATED AREA**

A. GENERAL

1. Seal off any openings at the perimeter of the regulated area with critical barriers to completely isolate the regulated area and to contain all airborne asbestos contamination created by the abatement activities. Should the adjacent area past the regulated area become contaminated due to improper work activities, the Contractor shall suspend work inside the regulated area, continue wetting, and clean the adjacent areas in accordance with procedures described in these specifications. Any and all costs associated with the adjacent area cleanup shall not be borne by the VA.

B. PREPARATION PRIOR TO SEALING OFF

1. Place all materials, equipment and supplies necessary to isolate the regulated area inside the regulated area. Remove all movable material/equipment as described above and secure all unmovable material/equipment as described above. Properly secured material/equipment shall be considered to be outside the regulated area.

C. CONTROLLING ACCESS TO THE REGULATED AREA

1. Access to the regulated area shall be permitted only through the PDF. All other means of access shall be closed off by proper sealing and DANGER signs posted on the clean side of the regulated area where it is adjacent to or within view of any occupiable area. An opaque visual barrier of 6 mil poly shall be provided so that the abatement work is not visible to any building occupants. If the area adjacent to the regulated area is accessible to the public, construct a solid barrier on the public side of the sheeting for protection and isolation of the project. The barrier shall be constructed with nominal 2" x 4" (50mm x 100mm) wood or metal studs 16" (400mm) on centers, securely anchored to prevent movement and covered with a minimum of 1/2" (12.5mm) plywood. Provide an appropriate number of OSHA DANGER signs for each visual and physical barrier. Any alternative method must be given a written approval by the VA's representative.

D. CRITICAL BARRIERS

1. Not applicable to outdoor abatement areas.

E. EXTENSION OF THE REGULATED AREA

1. Air monitoring at perimeter must indicate background levels (<0.01 f/cc).
2. Install as a drop sheeting within 10' of glovebag work. Floors shall be covered with 1 layer of 6 mil fire retardant poly.

### **3.4 REMOVAL OF piping ACM**

#### **A. WETTING MATERIALS**

1. Use amended water for the wetting of ACM prior to removal. The Competent Person shall assure the wetting of ACM meets the definition of "adequately wet" in the EPA NESHAP's regulation and OSHA's "wet methods" for the duration of the project. A removal encapsulant may be used instead of amended water with written approval of the VA's representative.
2. Amended Water: Provide water to which a surfactant has been added shall be used to wet the amosite or crocidolite ACM and reduce the potential for fiber release during disturbance of ACM. The mixture must be equal to or greater than the wetting provided by water amended by a surfactant consisting one ounce of 50% polyoxyethylene ester and 50% polyoxyethylene ether mixed with 5 gallons (19L) of water.
3. Removal Encapsulant: Provide a penetrating encapsulant designed specifically for the removal of ACM. The material must, when used, result in adequate wetting of the ACM and retard fiber release during disturbance equal to or greater than the amended water described above in B.

#### **B. SECONDARY BARRIER AND WALKWAYS**

1. Install as a drop cloth a 6 mil poly sheet at the beginning of each work shift where removal is to be done during that shift. Completely cover floors within 10 feet (3M) of the area where work is to done. Secure the secondary barrier with duct tape to prevent debris from getting behind it. Remove the secondary barrier at the end of the shift or as work in the area is completed. Keep residue on the secondary barrier wetted. When removing, fold inward to prevent spillage and place in a disposal bag.
2. Install walkways using 6 mil poly between the regulated area and the decontamination facilities (PDF and W/EDF) to protect the floor from contamination and damage. Install the walkways at the beginning of each shift and remove at the end of each shift.

#### **C. WET REMOVAL OF ACM**

1. Using acceptable glovebag procedures, adequately and thoroughly wet the ACM to be removed prior to removal to reduce/prevent fiber release to the air. Adequate time must be allowed for the amended water to saturate the ACM. Abatement personnel must not disturb dry ACM. Use a fine spray of amended water or removal encapsulant. Saturate the material sufficiently to wet to the substrate without causing excessive dripping. The material must be sprayed repeatedly/continuously during the removal process in order to maintain adequately wet conditions. Removal encapsulants must be applied in accordance with the manufacturer's written instructions. Perforate or carefully separate, using wet methods, an outer covering that is painted or jacketed in order to allow penetration and wetting of the material. Where necessary, carefully remove covering while wetting to minimize fiber release. In no event shall dry removal occur except in the case of electrical hazards or a greater safety issue is possible!



### 3.5 GLOVEBAG REMOVAL PROCEDURES

#### A. GENERAL

1. All applicable OSHA requirements and glovebag manufacturer's recommendations shall be met during glove bagging operations.
2. Mix the surfactant with water in the garden sprayer, following the manufacturer's directions.
3. Have each employee put on a HEPA filtered respirator approved for asbestos and check the fit using the positive/negative fit check.
4. Have each employee put on a disposable full-body suit. Remember, the hood goes over the respirator straps.
5. Check closely the integrity of the glove bag to be used. Check all seams, gloves, sleeves, and glove openings. OSHA requires the bottom of the bag to be seamless.
6. Check the pipe where the work will be performed. If it is damaged (broken lagging, hanging, etc.), wrap the entire length of the pipe in poly sheeting and "candy stripe" it with duct tape.
7. Attach glovebag with required tools per manufacturer's instructions.
8. Using the smoke tube and aspirator bulb, test 10% of glovebags by placing the tube into the water porthole (two-inch opening to glove bag), and fill the bag with smoke and squeeze it. If leaks are found, they should be taped closed using duct tape and the bag should be retested with smoke.
9. Insert the wand from the water sprayer through the water porthole.
10. Insert the hose end from a HEPA vacuum into the upper portion of the glove bag.
11. Wet and remove the pipe insulation.
12. If the section of pipe is covered with an aluminum jacket, remove it first using the wire cutters to cut any bands and the tin snips to remove the aluminum. It is important to fold the sharp edges in to prevent cutting the bag when placing it in the bottom.
13. When the work is complete, spray the upper portion of the bag and clean-push all residue into the bottom of the bag with the other waste material. Be very thorough. Use adequate water.
14. Put all tools, after washing them off in the bag, in one of the sleeves of glove bag and turn it inside out, drawing it outside of the bag. Twist the sleeve tightly several times to seal it and tape it several tight turns with duct tape. Cut through the middle of the duct tape and remove the sleeve. Put the sleeve in the next glove bag or put it in a bucket of water to decontaminate the tools after cutting the sleeve open.
15. Turn on the HEPA vacuum and collapse the bag completely. Remove the vacuum nozzle, seal the hole with duct tape, twist the bag tightly several times in the middle, and tape it to keep the material in the bottom during removal of the glove bag from the pipe.
16. Slip a disposal bag over the glove bag (still attached to the pipe).

Remove the tape securing the ends, and slit open the top of the glove bag and carefully fold it down into the disposal bag. Double bag and gooseneck waste materials.

B. NEGATIVE PRESSURE GLOVEBAG PROCEDURE

1. In addition to the above requirements, the HEPA vacuum shall be run continuously during the glovebag procedure until completion at which time the glovebag will be collapsed by the HEPA vacuum prior to removal from the pipe/component.
2. The HEPA vacuum shall be attached and operated as needed to prevent collapse of the glovebag during the removal process.

**3.6 LOCKDOWN ENCAPSULATION**

A. GENERAL

1. Lockdown encapsulation is an integral part of the ACM removal. At the conclusion of ACM removal and before removal of the primary barriers, all piping surfaces shall be encapsulated with a bridging encapsulant.

B. SEALING EXPOSED EDGES

1. Seal edges of ACM exposed by removal work with two coats of encapsulant. Prior to sealing, permit the exposed edges to dry completely to permit penetration of the encapsulant.

**3.7 DISPOSAL OF ACM WASTE MATERIALS**

A. GENERAL

1. Dispose of waste ACM and debris which is packaged in accordance with these specifications, OSHA, EPA and DOT. The landfill requirements for packaging must also be met. Disposal shall be done at the approved landfill. Disposal of non-friable ACM shall be done in accordance with applicable regulations.

B. PROCEDURES

1. Asbestos waste shall be packaged and moved through the W/EDF into a covered transport container in accordance with procedures in this specification. Waste shall be double-bagged prior to disposal. Wetted waste can be very heavy. Bags shall not be overfilled. Bags shall securely sealed to prevent accidental opening and/or leakage. The top shall be tightly twisted and goosenecked prior to tightly sealing with at least three wraps of duct tape. Ensure that unauthorized persons do not have access to the waste material once it is outside the regulated area. All transport containers must be covered at all times when not in use. NESHAP's signs must be on containers during loading and unloading. Material shall not be transported in open vehicles. If drums are used for packaging, the drums shall be labeled properly and shall not be re-used.
2. Waste Load Out: Waste load out shall be done in accordance with the procedures in W/EDF Decontamination Procedures. Bags shall be decontaminated on exterior surfaces by wet cleaning and/or HEPA vacuuming before being placed in the second bag.

3. Asbestos waste with sharp edged components, i.e., nails, screws, lath, strapping, tin sheeting, jacketing, metal mesh, etc., which might tear poly bags shall be wrapped securely in burlap before packaging and, if needed, use a poly lined fiber drum as the second container, prior to disposal.

### **3.8 PROJECT DECONTAMINATION**

#### **A. GENERAL**

1. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH.
2. If the asbestos abatement work is in an area which was contaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal and cleaning of the regulated area surfaces after the primary barrier removal.
3. If the asbestos abatement work is in an area which was uncontaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal, thus preventing contamination of the building when the regulated area critical barriers are removed.

#### **B. REGULATED AREA CLEARANCE**

1. Air testing and other requirements which must be met before release of the Contractor and re-occupancy of the regulated area space are specified in Final Testing Procedures.

#### **C. WORK DESCRIPTION**

1. Decontamination includes the cleaning and clearance of the air in the regulated area and the decontamination and removal of the enclosures/facilities installed prior to the abatement work including primary/critical barriers, PDF and W/EDF facilities.

#### **D. PRE-DECONTAMINATION CONDITIONS**

1. Before decontamination starts, all ACM waste from the regulated area shall be removed, all waste collected and removed, and the secondary barrier of poly removed and disposed of along with any gross debris generated by the work.
2. At the start of decontamination, the following shall be in place:
  - a. Critical barriers over all openings consisting of two layers of 6 mil poly which is the sole barrier between the regulated area and the rest of the building or outside.
  - b. Decontamination facilities, if required for personnel and equipment in operating condition.

#### **E. FIRST CLEANING**

1. Carry out a first cleaning of all surfaces of the regulated area including items of remaining poly sheeting, tools, scaffolding, ladders/staging by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping methods. Use each surface of a cleaning cloth one time only and then dispose of as contaminated waste. Continue this

cleaning until there is no visible residue from abated surfaces or poly or other surfaces. If determined by the CPIH/VPIH/CIH additional cleaning(s) may be needed.

F. PRE-CLEARANCE INSPECTION AND TESTING

1. The CPIH and VPIH/CIH will perform a thorough and detailed visual inspection after the first cleaning to determine whether there is any visible residue in the regulated area. If the visual inspection is acceptable, the CPIH will perform pre-clearance sampling using aggressive clearance as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A(III) (B) (7) (d). If the sampling results show values below 0.01 f/cc, then the Contractor shall notify the VA's representative of the results with a brief report from the CPIH documenting the inspection and sampling results and a statement verifying that the regulated area is ready for lockdown encapsulation. The VA reserves the right to utilize their own VPIH/CIH to perform a pre-clearance inspection and testing for verification.

G. LOCKDOWN ENCAPSULATION OF ABATED SURFACES

1. With the express written permission of the VA's representative, perform lockdown encapsulation of all surfaces from which asbestos was abated in accordance with the procedures in this specification.

**3.9 FINAL VISUAL INSPECTIONS AND AIR CLEARANCE TESTING**

A. GENERAL

1. Notify the VA representative 24 hours in advance for the performance of the final visual inspection and testing. The final visual inspection and testing will be performed by the VPIH/CIH after the final cleaning.

B. FINAL VISUAL INSPECTION

1. Final visual inspection will include the entire regulated area, the PDF, all poly sheeting, seals over HVAC openings, doorways, windows, and any other openings. If any debris, residue, dust or any other suspect material is detected, the final cleaning shall be repeated at no cost to the VA. Dust/material samples may be collected and analyzed at no cost to the VA at the discretion of the VPIH/CIH to confirm visual findings. When the regulated area is visually clean the final testing can be done.

C. FINAL AIR CLEARANCE TESTING

1. The VPIH/CIH and VA Representative, the VPIH/CIH will perform the final visual inspection. Perimeter air samples will be collected and analyzed in accordance with procedures for PCM/TEM in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures. Additional inspection and testing will be done at the expense of the Contractor.
2. If the results of the PCM/TEM are acceptable, remove the regulated work areas an drop sheeting. Any small quantities of residue material

found upon removal of the poly shall be removed with a HEPA vacuum and localized isolation. If significant quantities are found as determined by the VPIH/CIH, then the entire area affected shall be cleaned as specified in the final cleaning.

3. When release criteria are met, proceed to perform the abatement closeout and to issue the certificate of completion in accordance with these specifications.

D. FINAL AIR CLEARANCE PROCEDURES

1. Final air clearance procedures will not be required for outdoor abatement work.
2. If indoor abatement, then Contractor's Release Criteria shall be as follows: Work in a regulated area is complete when the regulated area is visually clean and airborne fiber levels have been reduced to or below 0.01 f/cc as measured with PCM/TEM methods.
3. Air Monitoring and Final Clearance Sampling: To determine if the elevated airborne fiber counts encountered during abatement operations have been reduced to the specified level, the VPIH/CIH will secure samples and analyze them according to the following procedures:
  - a. Fibers Counted: "Fibers" referred to in this section shall be either all fibers regardless of composition as counted in the NIOSH 7400 PCM method or asbestos fibers counted using the TEM method.
  - b. Aggressive Sampling: All final air testing samples shall be collected using aggressive sampling techniques. Samples will be collected on 0.8 $\mu$  MCE filters for PCM analysis and 0.45 $\mu$  Polycarbonate filters for TEM analysis. Before pumps are started, initiate aggressive sampling as detailed in 40 CFR 763 Subpart E (AHERA) Appendix A (III) (B) (7) (d). Air samples will be collected in areas subject to normal air circulation away from corners, obstructed locations, and locations near windows, doors, or vents. After air sampling pumps have been shut off, circulating fans shall be shut off.

E. CLEARANCE SAMPLING USING PCM

1. The NIOSH 7400 method will be used for clearance sampling with a minimum collection volume of 1200 Liters of air. A minimum of 5 PCM clearance samples will be collected.

F. CLEARANCE SAMPLING USING TEM

1. TEM clearance requires a minimum of 13 samples taken and analyzed, including five samples in the regulated area, five samples outside the regulated area and three field blanks using polycarbonate filters.

G. LABORATORY TESTING OF PCM SAMPLES

1. The services of an AIHA accredited laboratory will be employed by the VA to perform analysis of the air samples. Samples will be sent by the VPIH/CIH so that verbal/faxed reports can be received within 24 hours. A complete record, certified by the laboratory, of all air monitoring tests and results will be furnished to the VA's

representative and the Contractor.

H. LABORATORY TESTING OF TEM SAMPLES

1. Samples shall be sent by the VPIH/CIH to an accredited laboratory for analysis by TEM. Verbal/faxed results from the laboratory shall be available within 24 hours after receipt of the samples. A complete record, certified by the laboratory, of all TEM results shall be furnished to the VA's representative and the Contractor.

**3.10 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE**

A. COMPLETION OF ABATEMENT WORK: After thorough decontamination, complete asbestos abatement work upon meeting the regulated area clearance criteria and fulfilling the following:

1. Remove all equipment, materials, and debris from the project area.
2. Package and dispose of all asbestos waste as required.
3. Repair or replace all interior finishes damaged during the abatement work.
4. Fulfill other project closeout requirements as specified elsewhere in this specification.

B. CERTIFICATE OF COMPLETION BY CONTRACTOR

1. The CPIH shall complete and sign the "Certificate of Completion" in accordance with Attachment 1 at the completion of the abatement and decontamination of the regulated area.

C. WORK SHIFTS

1. All work shall be done during administrative hours (8:00 AM to 4:30 PM) Monday - Friday excluding Federal Holidays. Any change in the work schedule must be approved in writing by the VA Representative.

D. RE-INSULATION

1. If required as part of the contract, replace all asbestos containing insulation with suitable non-asbestos material. Provide MSDS's for all replacement materials. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

ATTACHMENT #1

CERTIFICATE OF COMPLETION

DATE: \_\_\_\_\_

PROJECT NAME: \_\_\_\_\_

VAMC/ADDRESS: \_\_\_\_\_

1. I certify that I have personally inspected, monitored and supervised the abatement work of  
(specify regulated area or Building):  
which took place from \_\_\_\_\_ to \_\_\_\_\_.
2. That throughout the work all applicable requirements/regulations and the VA's specifications were met.
3. That any person who entered the regulated area was protected with the appropriate personal protective equipment and respirator and that they followed the proper entry and exit procedures and the proper operating procedures for the duration of the work.
4. That all employees of the Abatement Contractor engaged in this work were trained in respiratory protection, were experienced with abatement work, had proper medical surveillance documentation, were fit-tested for their respirator, and were not exposed at any time during the work to asbestos without the benefit of appropriate respiratory protection.
5. That I performed and supervised all inspection and testing specified and required by applicable regulations and VA specifications.
6. That the conditions inside the regulated area were always maintained in a safe and healthy condition and the maximum fiber count never exceeded 0.5 f/cc, except as described below.
7. That all glovebag work was done in accordance with OSHA requirements and the manufacturer's recommendations.

CPIH Name: \_\_\_\_\_

Signature/Date: \_\_\_\_\_

Asbestos Abatement Contractor's Name:

\_\_\_\_\_

Signature/Date: \_\_\_\_\_

ATTACHMENT #2

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

DATE: \_\_\_\_\_

PROJECT NAME: \_\_\_\_\_

PROJECT ADDRESS: \_\_\_\_\_

ABATEMENT CONTRACTOR'S NAME: \_\_\_\_\_

WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC. Your employer's contract with the owner for the above project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of the equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided at no cost to you. By signing this certificate you are indicating to the owner that your employer has met these obligations.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of the written Respiratory Protection Program issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project.

TRAINING COURSE: I have been trained by a third party, State/EPA accredited trainer in the requirements for an AHERA/OSHA Asbestos Abatement Worker training course, 32 hours minimum duration. I currently have a valid State accreditation certificate. The topics covered in the course include, as a minimum, the following:  
Physical Characteristics and Background Information on Asbestos  
Potential Health Effects Related to Exposure to Asbestos  
Employee Personal Protective Equipment  
Establishment of a Respiratory Protection Program  
State of the Art Work Practices  
Personal Hygiene  
Additional Safety Hazards  
Medical Monitoring  
Air Monitoring  
Relevant Federal, State and Local Regulatory Requirements, Procedures, and Standards  
Asbestos Waste Disposal

MEDICAL EXAMINATION: I have had a medical examination within the past 12 months which was paid for by my employer. This examination included: health history, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. The physician issued a positive written opinion after the examination.

Signature: \_\_\_\_\_

Social Security Number: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Witness: \_\_\_\_\_



ATTACHMENT #3

AFFIDAVIT OF MEDICAL SURVEILLANCE, RESPIRATORY PROTECTION AND  
TRAINING/ACCREDITATION

VA PROJECT NAME AND NUMBER:

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VA MEDICAL FACILITY:

---

ABATEMENT CONTRACTOR'S NAME AND ADDRESS:

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1. I verify that the following individual

Name: \_\_\_\_\_ Social Security Number: \_\_\_\_\_

who is proposed to be employed in asbestos abatement work associated with the above project by the named Abatement Contractor, is included in a medical surveillance program in accordance with 29 CFR 1926.1101(m), and that complete records of the medical surveillance program as required by 29 CFR 1926.1101(m)(n) and 29 CFR 1910.20 are kept at the offices of the Abatement Contractor at the following address.

Address:

2. I verify that this individual has been trained, fit-tested and instructed in the use of all appropriate respiratory protection systems and that the person is capable of working in safe and healthy manner as expected and required in the expected work environment of this project.
3. I verify that this individual has been trained as required by 29 CFR 1926.1101(k). This individual has also obtained a valid State accreditation certificate. Documentation will be kept on-site.
4. I verify that I meet the minimum qualifications criteria of the VA specifications for a CPIH.

Signature of CPIH: \_\_\_\_\_ Date: \_\_\_\_\_

Printed Name of CPIH: \_\_\_\_\_

Signature of Contractor: \_\_\_\_\_ Date: \_\_\_\_\_

Printed Name of Contractor: \_\_\_\_\_

ATTACHMENT #4

ABATEMENT CONTRACTOR/COMPETENT PERSON(S) REVIEW AND ACCEPTANCE OF THE VA'S  
ASBESTOS SPECIFICATIONS

VA Project Location:

\_\_\_\_\_

VA Project #:

\_\_\_\_\_

VA Project Description:

\_\_\_\_\_

This form shall be signed by the Asbestos Abatement Contractor Owner and the Asbestos Abatement Contractor's Competent Person(s) prior to any start of work at the VA related to this Specification. If the Asbestos Abatement Contractor's/Competent Person(s) has not signed this form, they shall not be allowed to work on-site.

I, the undersigned, have read VA's Asbestos Specification regarding the asbestos abatement requirements. I understand the requirements of the VA's Asbestos Specification and agree to follow these requirements as well as all required rules and regulations of OSHA/EPA/DOT and State/Local requirements. I have been given ample opportunity to read the VA's Asbestos Specification and have been given an opportunity to ask any questions regarding the content and have received a response related to those questions. I do not have any further questions regarding the content, intent and requirements of the VA's Asbestos Specification.

At the conclusion of the asbestos abatement, I will certify that all asbestos abatement work was done in accordance with the VA's Asbestos Specification and all ACM was removed properly and no fibrous residue remains on any abated surfaces.

Abatement Contractor Owner's Signature \_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_

Abatement Contractor Competent Person(s) \_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_

--- E N D ---

**SECTION 02 82 13.31**

**ASBESTOS ABATEMENT: STEAM TUNNEL TAR PAPER JACKETING**

**PART 1 - GENERAL**

**1.1 SUMMARY OF THE WORK**

**A. CONTRACT DOCUMENTS AND RELATED REQUIREMENTS**

1. Drawings, general provisions of the contract, including general and supplementary conditions and other Division 01 specifications, shall apply to the work of this section. The contract documents show the work to be done under the contract and related requirements and conditions impacting the project. Related requirements and conditions include applicable codes and regulations, notices and permits, existing site conditions and restrictions on use of the site, requirements for partial owner occupancy during the work, coordination with other work and the phasing of the work. In the event the Asbestos Abatement Contractor (Contractor) discovers a conflict in the contract documents and/or requirements or codes, the conflict must be brought to the immediate attention of the Contracting Officer for resolution. Whenever there is a conflict or overlap in the requirements, the most stringent shall apply. Any actions taken by the Contractor without obtaining guidance from the Contracting Officer shall become the sole risk and responsibility of the Contractor. All cost incurred due to such action are also the responsibility of the Contractor.

**B. EXTENT OF WORK**

1. Below is a brief description of the steam tunnel asbestos transite materials to be abated. These material descriptions are for informational purposes only and are based on the best information available at the time of the specification preparation. The Contractor shall satisfy himself as the actual quantities to be abated based on linear feet found on the drawings. Nothing in this section may be interpreted as limiting the extent of work otherwise required by this contract and related documents.
2. Acumen conducted an inspection of the steam tunnel during our survey of Building 4. Based upon our limited inspection of the main steam tunnel supply and return lines include 5-inch outer diameter pipes that are insulated an ACM tar paper jacketing. ACM Tar paper jacketing contains 15% and is found on other pipes (including fiberglass insulated pipes, up to 20-inch diameter) within the main steam tunnel. Acumen noted hard pack insulation under sheet metal jacketing on large diameter (20-inch outer diameter) pipes in the steam tunnel does not contain asbestos.
3. Typically a white hard-pack magnesium silicate ACM pipe insulation was used within steam tunnels. This should also be assumed to be present, therefore notification to the BAAQMD will be required. If present, the provisions of SECTION 02 82 13.13 GLOVEBAG ASBESTOS

ABATEMENT, will also be required.

C. RELATED WORK

1. Section 02 41 00, DEMOLITION.

D. TASKS

1. The work tasks are summarized briefly as follows:
  - a. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, work-site preparations, emergency procedures arrangements, and standard operating procedures for Class II asbestos abatement work.
  - b. Abatement activities including removal, clean-up and disposal of ACM waste, recordkeeping, security, monitoring, and inspections.
  - c. Cleaning and decontamination activities including final visual inspection, air monitoring and certification of decontamination.

E. ABATEMENT CONTRACTOR USE OF PREMISES

1. The Contractor and Contractor's personnel shall cooperate fully with the VA representative/consultant to facilitate efficient use of buildings and areas within buildings. The Contractor shall perform the work in accordance with the VA specifications, drawings, phasing plan and in compliance with any/all applicable Federal, State and Local regulations and requirements.
2. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved pre-abatement work plan. Asbestos abatement drawings of partially occupied buildings will show the limits of regulated areas; the placement of decontamination facilities; the temporary location of bagged waste ACM; the path of transport to outside the building; and the temporary waste storage area for each building/regulated area. Any variation from the arrangements shown on drawings shall be secured in writing from the VA representative through the pre-abatement plan of action. The following limitations of use shall apply to existing facilities shown on drawings:

**1.2 VARIATIONS IN QUANTITY**

- A. The quantities and locations of ACM as indicated on the drawings and the extent of work included in this section are estimates which are limited by the physical constraints imposed by occupancy of the buildings. Accordingly, minor variations (+/- 5%) in quantities of ACM within the regulated area are considered as having no impact on contract price and time requirements of this contract. Where additional work is required beyond the above variation, the Contractor shall provide unit prices for additional work that is newly discovered materials and those prices will be used for additional work under the contract.

**1.3 STOP ASBESTOS REMOVAL**

- A. If the Contracting Officer or their field representative presents a written Stop Asbestos Removal Order, the Contractor/Personnel shall immediately

stop all asbestos removal and adequately wet any exposed ACM. The Contractor shall not resume any asbestos removal activity until authorized to do so by the VA. A stop asbestos removal order may be issued at any time the VA determines abatement conditions/ activities are not within specification requirements. Work stoppage will continue until conditions have been corrected to the satisfaction of the VA. Standby time and costs for corrective actions will be borne by the Contractor, including the industrial hygienist's time. The occurrence of any of the following events shall be reported immediately by the Contractor in writing to the VA representative and shall require the Contractor to immediately stop asbestos removal activities and initiate fiber reduction activities:

- B.  $\geq$  0.01 f/cc outside a regulated area or  $>0.05$  f/cc inside a regulated area;
- C. breach/break in regulated area critical barrier(s)/floor;
- D. serious injury/death at the site;
- E. fire/safety emergency at the site;
- F. respiratory protection system failure;
- G. power failure loss of wetting agent; or
- H. any visible emissions observed outside the regulated area.

#### **1.4 DEFINITIONS**

##### **A. GENERAL**

1. Definitions and explanations here are neither complete nor exclusive of all terms used in the contract documents, but are general for the work to the extent they are not stated more explicitly in another element of the contract documents. Drawings must be recognized as diagrammatic in nature and not completely descriptive of the requirements indicated therein.

##### **B. GLOSSARY**

1. Abatement - Procedures to control fiber release from asbestos-containing materials, typically during removal. Includes removal, encapsulation, enclosure, demolition and renovation activities related to asbestos.
2. ACE - Asbestos contaminated elements.
3. ACM - Asbestos containing material.
4. Aerosol - Solid or liquid particulate suspended in air.
5. Adequately wet - Sufficiently mixed or penetrated with liquid to prevent the release of particulates. If visible emissions are observed coming from the ACM, then that material has not been adequately wetted.
6. Aggressive method - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.

7. Aggressive sampling - EPA AHERA defined clearance sampling method using air moving equipment such as fans and leaf blowers to aggressively disturb and maintain in the air residual fibers after abatement.
8. AHERA - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.
9. Aircell - Pipe or duct insulation made of corrugated cardboard which contains asbestos.
10. Air monitoring - The process of measuring the fiber content of a known volume of air collected over a specified period of time. The NIOSH 7400 Method, Issue 2 is used to determine the fiber levels in air.
11. Air sample filter - The filter used to collect fibers which are then counted. The filter is made of mixed cellulose ester membrane for PCM (Phase Contrast Microscopy) and polycarbonate for TEM (Transmission Electron Microscopy)
12. Amended water - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.
13. Asbestos - Includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated or altered. Asbestos also includes PACM, as defined below.
14. Asbestos-containing material (ACM) - Any material containing more than one percent asbestos.
15. Asbestos contaminated elements (ACE) - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.
16. Asbestos-containing waste material - Asbestos-containing material or asbestos contaminated objects requiring disposal.
17. Asbestos waste decontamination facility - A system consisting of drum/bag washing facilities and a temporary storage area for cleaned containers of asbestos waste. Used as the exit for waste and equipment leaving the regulated area. In an emergency, it may be used to evacuate personnel.
18. Authorized person - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.
19. Authorized visitor - Any person approved by the VA; the contractor; or any government agency having jurisdiction over the regulated area.
20. Barrier - Any surface that isolates the regulated area and inhibits fiber migration from the regulated area.
21. Containment Barrier - An airtight barrier consisting of walls, floors, and/or ceilings of sealed plastic sheeting which surrounds and seals the outer perimeter of the regulated area.
22. Critical Barrier - The barrier responsible for isolating the regulated area from adjacent spaces, typically constructed of plastic sheeting secured in place at openings such as doors, windows, or any other opening into the regulated area.

23. Primary Barrier - Barriers placed over critical barriers and exposed directly to abatement work.
24. Secondary Barrier - Any additional sheeting used to isolate and provide protection from debris during abatement work.
25. Breathing zone - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.
26. Bridging encapsulant - An encapsulant that forms a layer on the surface of the ACM.
27. Building/facility owner - The legal entity, including a lessee, which exercises control over management and recordkeeping functions relating to a building and/or facility in which asbestos activities take place.
28. Bulk testing - The collection and analysis of suspect asbestos containing materials.
29. Certified Industrial Hygienist (CIH) - One certified in practice of industrial hygiene by the American Board of Industrial Hygiene. An industrial hygienist Certified in Comprehensive Practice by the American Board of Industrial Hygiene.
30. Class I asbestos work - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).
31. Class II asbestos work - Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic.
32. Clean room/Changing room - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.
33. Clearance sample - The final air sample taken after all asbestos work has been done and visually inspected.
34. Performed by the VA's industrial hygiene consultant (VPIH).
35. Closely resemble - The major workplace conditions which have contributed to the levels of historic asbestos exposure, are no more protective than conditions of the current workplace.
36. Competent person - In addition to the definition in 29 CFR 1926.32(f), one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f); in addition, for Class I and II work who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor.
37. Contractor's Professional Industrial Hygienist (CPIH) - The Contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of the PIH.
38. Count - Refers to the fiber count or the average number of fibers

- greater than five microns in length per cubic centimeter of air.
39. Decontamination area/unit - An enclosed area adjacent to and connected to the regulated area and consisting of an equipment room, shower room, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.
  40. Demolition - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.
  41. Disposal bag - Typically 6 mil thick siftproof, dustproof, leaktight container used to package and transport asbestos waste from regulated areas to the approved landfill. Each bag/container must be labeled/marked in accordance with EPA, OSHA and DOT requirements.
  42. Disturbance - Activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM. Disturbance includes cutting away small amounts of ACM or PACM, no greater than the amount that can be contained in one standard sized glove bag or waste bag in order to access a building component. In no event shall the amount of ACM or PACM so disturbed exceed that which can be contained in one glove bag or disposal bag which shall not exceed 60 inches in length or width.
  43. Drum - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be siftproof, dustproof, and leaktight.
  44. Employee exposure - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.
  45. Encapsulant - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.
  46. Encapsulation - Treating ACM with an encapsulant.
  47. Enclosure - The construction of an air tight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.
  48. Equipment room - A contaminated room located within the decontamination area that is supplied with impermeable bags or containers for the disposal of contaminated protective clothing and equipment.
  49. Fiber - A particulate form of asbestos, 5 microns or longer, with a length to width ratio of at least 3 to 1.
  50. Fibers per cubic centimeter (f/cc) - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.
  51. Filter - Media used in respirators, vacuums, or other machines to remove particulate from air.
  52. Firestopping - Material used to close the open parts of a structure in order to prevent a fire from spreading.
  53. Friable asbestos containing material - Any material containing more than 1 percent asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR 763, Section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced



- to powder by hand pressure.
54. Glovebag - Not more than a 60 x 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which materials and tools may be handled.
  55. High efficiency particulate air (HEPA) filter - A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 microns or greater in diameter.
  56. HEPA vacuum - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.
  57. Homogeneous area - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.
  58. HVAC - Heating, Ventilation and Air Conditioning
  59. Industrial hygienist - A professional qualified by education, training, and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards. Meets definition requirements of the American Industrial Hygiene Association (AIHA).
  60. Industrial hygienist technician - A person working under the direction of an IH or CIH who has special training, experience, certifications and licenses required for the industrial hygiene work assigned.
  61. Intact - The ACM has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix.
  62. Lockdown - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.
  63. National Emission Standards for Hazardous Air Pollutants (NESHAP's) - EPA's rule to control emissions of asbestos to the environment.
  64. Negative initial exposure assessment - A demonstration by the employer which complies with the criteria in 29 CFR 1926.1101 (f) (2) (iii), that employee exposure during an operation is expected to be consistently below the PEL's.
  65. Negative pressure - Air pressure which is lower than the surrounding area, created by exhausting air from a sealed regulated area through HEPA equipped filtration units. OSHA requires maintaining -0.02" water gauge inside the negative pressure enclosure.
  66. Negative pressure respirator - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air outside the respirator.
  67. Non-friable ACM - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.
  68. Organic vapor cartridge - The type of cartridge used on air purifying respirators for organic vapor exposures.
  69. Outside air - The air outside buildings and structures, including,

- but not limited to, the air under a bridge or in an open ferry dock.
70. Owner/operator - Any person who owns, leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns, leases, operates, controls, or supervises the demolition or renovation operation, or both.
  71. Penetrating encapsulant - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.
  72. Personal sampling/monitoring - Representative air samples obtained in the breathing zone of the person using a cassette and battery operated pump to determine asbestos exposure.
  73. Permissible exposure limit (PEL) - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the PEL is 0.1 fibers per cc.
  74. Polarized light microscopy (PLM) - Light microscopy using dispersion staining techniques and refractive indices to identify and quantify the type(s) of asbestos present in a bulk sample.
  75. Polyethylene sheeting - Strong plastic barrier material 4 to 6 mils thick, semi-transparent, sometimes flame retardant in compliance with NFPA 241.
  76. Positive/negative fit check - A method of verifying the fit of a respirator by closing off the filters and breathing in or closing off the exhalation valve and breathing out while detecting leakage of the respirator.
  77. Presumed ACM (PACM) - Thermal system insulation, surfacing, and flooring material installed in buildings prior to 1981. If the building owner has actual knowledge, or should have known through the exercise of due diligence that other materials are ACM, they too must be treated as PACM. The designation of PACM may be rebutted pursuant to 29 CFR 1926.1101 (k) (5).
  78. Professional IH - An IH who meets the definition requirements of AIHA; meets the definition requirements of OSHA as a "Competent Person" at 29 CFR 1926.1101 (b); has completed two specialized EPA approved courses on management and supervision of asbestos abatement projects; has formal training in respiratory protection and waste disposal; and has a minimum of four projects of similar complexity with this project of which at least three projects serving as the supervisory IH.
  79. Project designer - A person who has successfully completed the training requirements for an asbestos abatement project designer as required by 40 CFR 763 Appendix C, Part I; (B) (5).
  80. Protection factor - A value assigned by OSHA/NIOSH to indicate the assigned protection a respirator should provide if worn properly. The number indicates the reduction of exposure level from outside to inside the respirator.
  81. Qualitative fit test (QLFT) - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.
  82. Quantitative fit test (QNFT) - A fit test using a challenge material which is quantified outside and inside the respirator thus allowing the determination of the actual fit factor.

- 83. Regulated area - An area established by the employer to demarcate where Class I, II, III asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work may accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed the PEL.
- 84. Regulated ACM (RACM) - Friable ACM; Category I nonfriable ACM that has become friable; Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of the demolition or renovation operation.
- 85. Removal - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.
- 86. Renovation - Altering a facility or one or more facility components in any way, including the stripping or removal of asbestos from a facility component which does not involve demolition activity.
- 87. Repair - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.
- 88. Shower room - The portion of the PDF where personnel shower before leaving the regulated area. Also used for bag/drum decontamination in the EDF.
- 89. Standard operating procedures (SOP's) - Asbestos work procedures required to be submitted by the contractor before work begins.
- 90. Supplied air respirator (SAR) - A respirator that utilizes an air supply separate from the air in the regulated area.
- 91. Surfacing ACM - A material containing more than 1 percent asbestos that is sprayed, troweled on or otherwise applied to surfaces for acoustical, fireproofing and other purposes.
- 92. Surfactant - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.
- 93. Thermal system ACM - A material containing more than 1 percent asbestos applied to pipes, fittings, boilers, breeching, tanks, ducts, or other structural components to prevent heat loss or gain.
- 94. Transmission electron microscopy (TEM) - A microscopy method that can identify and count asbestos fibers.
- 95. VA Industrial Hygienist (VPIH/CIH) - Department of Veterans Affairs Professional Industrial Hygienist.
- 96. VA Representative - The VA official responsible for on-going project work.
- 97. Visible emissions - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM or ACM waste material.
- 98. Waste/Equipment decontamination area (W/EDA) - The area in which waste is packaged and equipment is decontaminated before removal from the

regulated area.

- 99. Waste generator - Any owner or operator whose act or process produces asbestos-containing waste material.
- 100. Waste shipment record - The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of asbestos-containing waste material.
- 101. Wet cleaning - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

C. REFERENCED STANDARDS ORGANIZATIONS

- 1. The following acronyms or abbreviations as referenced in contract/specification documents are defined to mean the associated names. Names and addresses may be subject to change.
  - a. VA Department of Veterans Affairs 810 Vermont Avenue, NW Washington, DC 20420
  - b. AIHA American Industrial Hygiene Association 2700 Prosperity Avenue, Suite 250 Fairfax, VA 22031 703-849-8888
  - c. ANSI American National Standards Institute 1430 Broadway New York, NY 10018 212-354-3300
  - d. ASTM American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103 215-299-5400
  - e. CFR Code of Federal Regulations Government Printing Office Washington, DC 20420
  - f. CGA Compressed Gas Association 1235 Jefferson Davis Highway Arlington, VA 22202 703-979-0900
  - g. CS Commercial Standard of the National Institute of Standards and Technology (NIST) U. S. Department of Commerce Government Printing Office Washington, DC 20420
  - h. EPA Environmental Protection Agency 401 M St., SW Washington, DC 20460 202-382-3949
  - i. MIL-STD Military Standards/Standardization Division Office of the Assistant Secretary of Defense Washington, DC 20420
  - j. MSHA Mine Safety and Health Administration Respiratory Protection Division Ballston Tower #3 Department of Labor Arlington, VA 22203 703-235-1452
  - k. NIST National Institute for Standards and Technology U. S. Department of Commerce Gaithersburg, MD 20899 301-921-1000
  - l. NEC National Electrical Code (by NFPA)
  - m. NEMA National Electrical Manufacturer's Association 2101 L Street, NW Washington, DC 20037
  - n. NFPA National Fire Protection Association 1 Batterymarch Park P.O. Box 9101 Quincy, MA 02269 617-671-1800 617-671-3555
  - o. NIOSH National Institutes for Occupational Safety and Health 4676 Columbia Parkway Cincinnati, OH 45226 513-533-8236
  - p. OSHA Occupational Safety and Health Administration U.S. Department of Labor Government Printing Office Washington, DC 20402

- q. UL Underwriters Laboratory 333 Pfingsten Rd. Northbrook, IL 60062 312-272-8800
- r. USA United States Army Army Chemical Corps Department of Defense Washington, DC 20420

## **1.5 APPLICABLE CODES AND REGULATIONS**

### **A. GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS**

1. All work under this contract shall be done in strict accordance with all applicable Federal, State, and local regulations, standards and codes governing asbestos abatement, and any other trade work done in conjunction with the abatement. All applicable codes, regulations and standards are adopted into this specification and will have the same force and effect as this specification.
2. The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specifications exists, the most stringent requirement(s) shall be utilized.
3. Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed in Section 1.5 shall be available at the worksite in the clean change area of the worker decontamination system.

### **B. CONTRACTOR RESPONSIBILITY**

1. The Contractor shall assume full responsibility and liability for compliance with all applicable Federal, State and Local regulations related to any and all aspects of the abatement project. The Contractor is responsible for providing and maintaining training, accreditations, medical exams, medical records, personal protective equipment as required by applicable Federal, State and Local regulations. The contractor shall hold the VA and VPIH/CIH consultants harmless for any failure to comply with any applicable work, packaging, transporting, disposal, safety, health, or environmental requirement on the part of himself, his employees, or his subcontractors. The contractor will incur all costs of the CPIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements.

### **C. FEDERAL REQUIREMENTS**

1. Federal requirements which govern some aspect of asbestos abatement include, but are not limited to, the following regulations.
2. Occupational Safety and Health Administration (**OSHA**)
  - a. Title 29 CFR 1926.1101 - Construction Standard for Asbestos
  - b. Title 29 CFR 1910.132 - Personal Protective Equipment
  - c. Title 29 CFR 1910.134 - Respiratory Protection
  - d. Title 29 CFR 1926 - Construction Industry Standards
  - e. Title 29 CFR 1910.20 - Access to Employee Exposure and Medical Records
  - f. Title 29 CFR 1910.1200 - Hazard Communication

- g. Title 29 CFR 1910.151 - Medical and First Aid
  - 3. Environmental Protection Agency (EPA)
    - a. 40 CFR 61 Subpart A and M (Revised Subpart B) - National Emission Standard for Hazardous Air Pollutants - Asbestos.
    - b. 40 CFR 763.80 - Asbestos Hazard Emergency Response Act (AHERA)
  - 4. Department of Transportation (DOT)
    - a. Title 49 CFR 100 - 185 - Transportation
- D. STATE REQUIREMENTS
  - 1. State requirements that apply to the asbestos abatement work, disposal, clearance, etc., include, but are not limited to, the following:
- E. LOCAL REQUIREMENTS
  - 1. If local requirements are more stringent than federal or state standards, the local standards are to be followed.
- F. STANDARDS
  - 1. Standards which govern asbestos abatement activities include, but are not limited to, the following:
    - a. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems Z88.2 - Practices for Respiratory Protection.
    - b. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA filter Units, 7th Edition.
  - 2. Standards which govern encapsulation work include, but are not limited to, the following:
    - a. American Society for Testing and Materials (ASTM)
  - 3. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:
    - a. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
    - b. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.
    - c. NFPA 101 - Life Safety Code
- G. EPA GUIDANCE DOCUMENTS
  - 1. EPA guidance documents which discuss asbestos abatement work activities are listed below. These documents are made part of this section by reference. EPA publications can be ordered from (800) 424-9065.
  - 2. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024
  - 3. Asbestos Waste Management Guidance EPA 530-SW-85-007

4. A Guide to Respiratory Protection for the Asbestos Abatement Industry  
EPA-560-OPTS-86-001
5. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

H. NOTICES

1. State and Local agencies: Send written notification as required by state and local regulations including the local fire department prior to beginning any work on ACM as follows:
2. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification is given to EPA, State, and Local authorities.

I. PERMITS/LICENSES

1. The contractor shall apply for and have all required permits and licenses to perform asbestos abatement work as required by Federal, State, and Local regulations.

J. POSTING AND FILING OF REGULATIONS

1. Maintain two (2) copies of applicable federal, state, and local regulations. Post one copy of each at the regulated area where workers will have daily access to the regulations and keep another copy in the Contractor's office.

K. VA RESPONSIBILITIES

1. Prior to commencement of work:
2. Notify occupants adjacent to regulated areas of project dates and requirements for relocation, if needed. Arrangements must be made prior to starting work for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the regulated area. **Note: Notification of adjacent personnel is required by OSHA in 29 CFR 1926.1101 (k) to prevent unnecessary or unauthorized access to the regulated area.**
3. Submit to the Contractor results of background air sampling; including location of samples, person who collected the samples, equipment utilized and method of analysis. During abatement, submit to the Contractor, results of bulk material analysis and air sampling data collected during the course of the abatement. This information shall not release the Contractor from any responsibility for OSHA compliance.

L. SITE SECURITY

1. Regulated area access is to be restricted only to authorized, trained/accredited and protected personnel. These may include the Contractor's employees, employees of Subcontractors, VA employees and representatives, State and local inspectors, and any other designated individuals. A list of authorized personnel shall be established prior to commencing the project and be posted in the clean room of the decontamination unit.

2. Entry into the regulated area by unauthorized individuals shall be reported immediately to the Competent Person by anyone observing the entry. The Competent person shall immediately notify the VA.
3. A log book shall be maintained in the clean room of the decontamination unit. Anyone who enters the regulated area must record their name, affiliation, time in, and time out for each entry.
4. Access to the regulated area shall be through of a critical barrier doorway. All other access (doors, windows, hallways, etc.) shall be sealed or locked to prevent entry to or exit from the regulated area. The only exceptions for this requirement are the waste/equipment load-out area which shall be sealed except during the removal of containerized asbestos waste from the regulated area, and emergency exits. Emergency exits shall not be locked from the inside, however, they shall be sealed with poly sheeting and taped until needed.
5. The Contractor's Competent Person shall control site security during abatement operations in order to isolate work in progress and protect adjacent personnel. A 24 hour security system shall be provided at the entrance to the regulated area to assure that all entrants are logged in/out and that only authorized personnel are allowed entrance.
6. The Contractor will have the VA's assistance in notifying adjacent personnel of the presence, location and quantity of ACM in the regulated area and enforcement of restricted access by the VA's employees.
7. The regulated area shall be locked during non-working hours and secured by VA security guards.

M. EMERGENCY ACTION PLAN AND ARRANGEMENTS

1. An Emergency Action Plan shall be developed by the Contractor prior to commencing abatement activities and shall be agreed to by the Contractor and the VA. The Plan shall meet the requirements of 29 CFR 1910.38 (a); (b).
2. Emergency procedures shall be in written form and prominently posted and available in the regulated area. Everyone, prior to entering the regulated area, must read and sign these procedures to acknowledge understanding of the regulated area layout, location of emergency exits and emergency procedures.
3. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule and layout of regulated area, particularly barriers that may affect response capabilities.
4. Emergency planning shall include consideration of fire, explosion, hazardous atmospheres, electrical hazards, slips/trips and falls, confined spaces, and heat stress illness. Written procedures for response to emergency situations shall be developed and employee training in procedures shall be provided.
5. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
  - a. For non life-threatening situations - employees injured or otherwise incapacitated shall decontaminate following normal



- procedures with assistance from fellow workers, if necessary, before exiting the regulated area to obtain proper medical treatment.
  - b. For life-threatening injury or illness, worker decontamination shall take least priority after measures to stabilize the injured worker, remove them from the regulated area, and secure proper medical treatment.
6. Telephone numbers of all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
  7. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3 minutes of a life-threatening injury/illness. Bloodborne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.
  8. The Emergency Action Plan shall provide for a Contingency Plan in the event that an incident occurs that may require the modification of the standard operating procedures during abatement. Such incidents include, but are not limited to, fire; accident; and power failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that work is stopped and wetting is continued until correction of the problem.

N. PRE-START MEETING

1. Prior to commencing the work, the Contractor shall meet with the VPCIH to present and review, as appropriate, the items following this paragraph. The Contractor's Competent Person(s) who will be on-site shall participate in the pre-start meeting. The pre-start meeting is to discuss and determine procedures to be used during the project. At this meeting, the Contractor shall provide:
2. Proof of Contractor licensing.
3. Proof the Competent Person is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person shall also be presented.
4. A list of all workers who will participate in the project, including experience and verification of training and accreditation.
5. A list of and verification of training for all personnel who have current first-aid/CPR training. A minimum of one person per shift must have adequate training.
6. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
7. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
8. A copy of the Contractor's Standard Operating Procedures for Class I Glovebag Asbestos Abatement. In these procedures, the following information must be detailed, specific for this project.
  - a. Regulated area preparation procedures;

- b. Notification requirements procedure of Contractor as required in 29 CFR 1926.1101 (d);
  - c. and Decontamination procedures for employees;
  - d. Class II abatement methods/procedures and equipment to be used;
  - e. Personal protective equipment to be used;
- 9. At this meeting the Contractor shall provide all submittals as required.
  - 10. Procedures for handling, packaging and disposal of asbestos waste.
  - 11. Emergency Action Plan and Contingency Plan procedures.

#### **1.6 PROJECT COORDINATION**

- A. The following are the minimum administrative and supervisory personnel necessary for coordination of the work.
- B. PERSONNEL
  - 1. Administrative and supervisory personnel shall consist of a qualified Competent Person as defined by OSHA in the Construction Standards and the Asbestos Construction Standard; Contractor Professional Industrial Hygienist and Industrial Hygiene Technicians. These employees are the Contractor's representatives responsible for compliance with these specifications and all other applicable requirements.
    - a. Non-supervisory personnel shall consist of an adequate number of qualified personnel to meet the schedule requirements of the project. Personnel shall meet required qualifications. Personnel utilized on-site shall be pre-approved by the VA representative. A request for approval shall be submitted for any person to be employed during the project giving the person's name; social security number; qualifications; accreditation card with picture; Certificate of Worker's Acknowledgment; and Affidavit of Medical Surveillance and Respiratory Protection and current Respirator Fit Test.
  - 2. Minimum qualifications for Contractor and assigned personnel are:
    - a. The Contractor has conducted within the last three (3) years, three (3) projects of similar complexity and dollar value as this project; has not been cited and penalized for serious violations of asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work; is licensed in applicable states; has adequate and qualified personnel available to complete the work; has comprehensive standard operating procedures for asbestos work; has adequate materials, equipment and supplies to perform the work.
    - b. The Competent Person has four (4) years of abatement experience of which two (2) years were as the Competent Person on the project; meets the OSHA definition of a Competent Person; has been the Competent Person on two (2) projects of similar size and complexity as this project; has completed EPA AHERA/OSHA/State/Local training requirements/accreditation(s) and refreshers; and has all required OSHA documentation related to medical and respiratory protection.

- c. The Contractor Professional Industrial Hygienist (CPIH) shall have five (5) years of monitoring experience and supervision of asbestos abatement projects; has participated as senior IH on five (5) abatement projects, three (3) of which are similar in size and complexity as this project; has developed at least one complete standard operating procedure for asbestos abatement; has trained abatement personnel for three (3) years; has specialized EPA AHERA/OSHA training in asbestos abatement management, respiratory protection, waste disposal and asbestos inspection; has completed the NIOSH 582 Course, Contractor/Supervisor course; and has appropriate medical/respiratory protection records/documentation.
- d. The Abatement Personnel shall have completed the EPA AHERA/OSHA abatement worker course; have training on the standard operating procedures of the Contractor; has one year of asbestos abatement experience; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

## **1.7 RESPIRATORY PROTECTION**

### **A. GENERAL - RESPIRATORY PROTECTION PROGRAM**

- 1. The Contractor shall develop and implement a Respiratory Protection Program (RPP) which is in compliance with the January 8, 1998 OSHA requirements found at 29 CFR 1926.1101 and 29 CFR 1910.132;134. ANSI Standard Z88.2-1992 provides excellent guidance for developing a respiratory protection program. All respirators used must be NIOSH approved for asbestos abatement activities. The written respiratory protection shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c) (1) (i - ix) - Respiratory Protection Program.

### **B. RESPIRATORY PROTECTION PROGRAM COORDINATOR**

- 1. The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years experience coordinating the program. The RPPC must provide a signed statement attesting to the fact that the program meets the above requirements.

### **C. SELECTION AND USE OF RESPIRATORS**

- 1. The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualification. The procedure must be written clearly enough for workers to understand. A copy of the Respiratory Protection Program must be available in the clean room of the decontamination unit for reference by employees or authorized visitors.

### **D. MINIMUM RESPIRATORY PROTECTION**

- 1. Minimum respiratory protection shall be a half face, HEPA filtered, air purifying respirator when fiber levels are maintained consistently at or below 0.1 f/cc. A higher level of respiratory protection may be provided or required, depending on fiber levels. Respirator selection shall meet the requirements of 29 CFR 1926.1101 (h); Table 1, except as indicated in this paragraph. Abatement

personnel must have a respirator for their exclusive use.

E. MEDICAL WRITTEN OPINION

1. No employee shall be allowed to wear a respirator unless a physician has determined they are capable of doing so and has issued a current written opinion for that person.

F. RESPIRATOR FIT TEST

1. All personnel wearing respirators shall have a current qualitative/quantitative fit test which was conducted in accordance with 29 CFR 1910.134 (f) and Appendix A. Fit tests shall be done for PAPR's which have been put into a failure mode.

G. RESPIRATOR FIT CHECK

1. The Competent Person shall assure that the positive/negative fit check is done each time the respirator is donned by an employee. Headcoverings must cover respirator headstraps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a fit check shall preclude that person from wearing a respirator until resolution of the problem.

H. MAINTENANCE AND CARE OF RESPIRATORS

1. The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) Maintenance and care of respirators.

**1.8 WORKER PROTECTION**

A. TRAINING OF ABATEMENT PERSONNEL

1. Prior to beginning any abatement activity, all personnel shall be trained in accordance with OSHA 29 CFR 1926.1101 (k)(9) and any additional State/Local requirements. Training must include, at a minimum, the elements listed at 29 CFR 1926.1101 (k)(9)(viii). Training shall have been conducted by a third party, EPA/State approved trainer meeting the requirements of EPA 40 CFR 763 Appendix C (AHERA MAP). Initial training certificates and current refresher and accreditation proof must be submitted for each person working at the site.

B. MEDICAL EXAMINATIONS

1. Medical examinations meeting the requirements of 29 CFR 1926.1101 (m) shall be provided for all personnel working in the regulated area, regardless of exposure levels. The physician's written opinion as required by 29 CFR 1926.1101 (m)(4) shall be provided for each person and shall include in the opinion the person has been evaluated for working in a heat stress environment while wearing personal protective equipment and is able to perform the work.

C. PERSONAL PROTECTIVE EQUIPMENT

1. Provide whole body clothing, head coverings, foot coverings and any other personal protective equipment as determined by conducting the

hazard assessment required by OSHA at 29 CFR 1910.132 (d). The Competent Person shall ensure the integrity of personal protective equipment worn for the duration of the project. Duct tape shall be used to secure all suit sleeves to wrists and to secure foot coverings at the ankle.

D. REGULATED AREA ENTRY PROCEDURE

1. Worker protection shall meet the most stringent requirements. The Competent Person shall ensure that each time workers enter the regulated area, they remove ALL street clothes in the clean room of the decontamination unit and put on new disposable coveralls, head coverings, a clean respirator, and then proceed through the shower room to the equipment room where they put on non-disposable required personal protective equipment.

E. DECONTAMINATION PROCEDURE

1. The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area.
2. When exiting the regulated area, remove all disposable PPE and dispose of in a disposal bag provided in the regulated area.
3. Carefully decontaminate and clean the respirator. Put in a clean container/bag.

F. REGULATED AREA REQUIREMENTS

1. The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for Class I glovebag regulated areas at 29 CFR 1926.1101 (e) are met applicable to Class II work. All personnel in the regulated area shall not be allowed to eat, drink, smoke, chew tobacco or gum, apply cosmetics, or in any way interfere with the fit of their respirator.

**1.9 DECONTAMINATION FACILITIES:**

A. DESCRIPTION:

1. Provide each regulated area with a decontamination facility. This shall consist of a scaffold or other rigid structure capable of supporting 6-mil poly sheeting for visual barrier. Provide a area for equipment and personal decontamination using soap and water. Provide with fiber drum with a disposal bag in it for personnel waste materials.

B. WASTE/EQUIPMENT DECONTAMINATION AREA (W/EDA) - The Competent Person shall provide a W/EDA for removal of all waste, equipment and contaminated material from the regulated area.

C. WASTE/EQUIPMENT DECONTAMINATION PROCEDURES: Contain all waste in 6 mil poly bags. Clean/decontaminate bags and pass through a double 6 mil flap doorway into another bag or fiber drum. Remove to disposal dumpster/gondola/vehicle. At no time shall unprotected personnel from the clean side be allowed to enter the regulated area.

## **PART 2 - PRODUCTS, MATERIALS AND EQUIPMENT**

### **2.1 MATERIALS AND EQUIPMENT**

#### **A. GENERAL REQUIREMENTS (all abatement projects)**

1. Prior to the start of work, the Contractor shall provide and maintain a sufficient quantity of materials and equipment to assure continuous and efficient work throughout the duration of the project. Work shall not start unless the following items have been delivered to the site and the CPIH has submitted verification to the VA's representative to this effect:
2. All materials shall be delivered in their original package, container or bundle bearing the name of the manufacturer and the brand name (where applicable).
3. Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Flammable materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated/work area until abatement is completed.
4. The Contractor shall not block or hinder use of buildings by patients, staff, and visitors to the VA in partially occupied buildings by placing materials/equipment in any unauthorized place.
5. The Competent Person shall inspect for damaged, deteriorating or previously used materials. Such materials shall not be used and shall be removed from the worksite and disposed of properly.
6. Poly sheeting for critical barriers/floors in the regulated area shall be 6 mil.
7. If required, the method of attaching polyethylene sheeting shall be agreed upon in advance by the Contractor and the VA and selected to minimize damage to equipment and surfaces.
8. An adequate number of infra-red heating units, HEPA vacuums, scrapers, sprayers, nylon brushes, brooms, disposable mops, rags, sponges, staple guns, shovels, ladders and scaffolding of suitable height and length as well as meeting OSHA requirements shall be provided. Fall protection devices, water hose to reach all areas in the regulated area, airless spray equipment, and any other tools, materials or equipment required to conduct the abatement project shall also be provided. All electrically operated hand tools, equipment, electric cords shall be equipped with GFCI protection.
9. Special protection for objects in the regulated area shall be detailed. (e.g., plywood over carpeting or hardwood floors to prevent damage from scaffolds, water, and falling material.)
10. Impermeable fiberboard drums and disposal bags 2 layers of 6 mil, for asbestos waste shall be pre-printed with labels, markings and address as required by OSHA, EPA and DOT regulations.
11. The VA shall be provided a copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication. Chlorinated compounds shall not be used with any spray adhesive or other product. Appropriate encapsulant(s) shall be

provided.

12. OSHA DANGER demarcation signs, as many and as required by OSHA 29 CFR 1926.1101(k) (7) shall be provided and placed by the Competent Person. All other posters and notices required by Federal and State regulations shall be posted in the Clean Room.
13. Adequate and appropriate PPE for the project and number of personnel/shifts shall be provided. All personal protective equipment issued must be based on a hazard assessment conducted under 29 CFR 1910.132(d).

## **2.2 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA**

### **A. GENERAL**

1. Using critical barriers, seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All horizontal surfaces, as required, in the regulated area must be covered with 2 layers of 6 mil fire retardant poly to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated, immediately stop work and clean up the contamination at no additional cost to the Government. Provide firestopping and identify all fire barrier penetrations due to abatement work as specified in Section 2.2.8; Section 07 84 00, FIRESTOPPING.2.2.2 PREPARATION PRIOR TO SEALING THE REGULATED AREA
2. Place all tools, scaffolding, materials and equipment needed for working in the regulated area prior to erecting any plastic sheeting. Remove all uncontaminated removable furniture, equipment and/or supplies from the regulated area before commencing work, or completely cover with two layers of 6-mil fire retardant poly sheeting and secure with duct tape. Lock out and tag out any HVAC systems in the regulated area.

### **B. CONTROLLING ACCESS TO THE REGULATED AREA**

1. Access to the regulated area is allowed only through the personnel decontamination facility (PDF), if required. All other means of access shall be eliminated and OSHA DANGER demarcation signs posted as required by OSHA. If the regulated area is adjacent to or within view of an occupied area, provide a visual barrier of 6 mil opaque fire retardant poly sheeting to prevent building occupant observation. If the adjacent area is accessible to the public, the barrier must be solid.

### **C. CRITICAL BARRIERS**

1. Completely separate any openings into the regulated area from adjacent areas using fire retardant poly at least 6 mils thick and duct tape. Individually seal with two layers of 6 mil poly and duct tape all HVAC openings into the regulated area. Individually seal all lighting fixtures, clocks, doors, windows, convectors, speakers, or any other objects in the regulated area. Heat must be shut off any objects covered with poly.
2. Secondary barriers:
  - a. A loose layer of 6 mil fire retardant poly shall be used as a drop

cloth to protect the floor/horizontal surfaces from debris generated during the Class II work, except for floor tile abatement. This layer shall be replaced as needed during the work.

D. EXTENSION OF THE REGULATED AREA

1. If the enclosure of the regulated area is breached in any way that could allow contamination to occur, the affected area shall be included in the regulated area and constructed as per this section. If the affected area cannot be added to the regulated area, decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

E. FIRESTOPPING:

1. Through penetrations caused by cables, cable trays, pipes, sleeves must be firestopped with a fire-rated firestop system providing an air tight seal.
2. Firestop materials that are not equal to the wall or ceiling penetrated shall be brought to the attention of the VA Representative. The Contractor shall list all areas of penetration, the type of sealant used, and whether or not the location is fire rated. Any discovery of penetrations during abatement shall be brought to the attention of the VA Representative immediately. All walls, floors and ceilings are considered fire rated unless otherwise determined by the VA Representative or Fire Marshall.
3. Any visible openings whether or not caused by a penetration shall be reported by the Contractor to the VA Representative for a sealant system determination. Firestops shall meet ASTM E814 and UL 1479 requirements for the opening size, penetrant, and fire rating needed.

## 2.3 MONITORING, INSPECTION AND TESTING

A. GENERAL

1. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. The CPIH shall periodically inspect and oversee the performance of the Contractor IH Technician. The IH Technician shall continuously inspect and monitor conditions inside the regulated area to ensure compliance with these specifications. In addition, the CPIH shall personally manage air sample collection, analysis, and evaluation for personnel, regulated area, and adjacent area samples to satisfy OSHA requirements. Additional inspection and testing requirements are also indicated in other parts of this specification.
2. The VA will employ an independent industrial hygienist (VPIH/CIH) consultant and/or use its own IH to perform various services on behalf of the VA. The VPIH/CIH will perform the necessary monitoring, inspection, testing, and other support services to ensure that VA patients, employees, and visitors will not be adversely affected by the abatement work, and that the abatement work proceeds in accordance with these specifications, that the abated areas or abated buildings have been successfully decontaminated. The work of the VPIH/CIH consultant in no way relieves the Contractor from their responsibility



to perform the work in accordance with contract/specification requirements, to perform continuous inspection, monitoring and testing for the safety of their employees, and to perform other such services as specified. The cost of the VPIH/CIH and their services will be borne by the VA except for any repeat of final inspection and testing that may be required due to unsatisfactory initial results. Any repeated final inspections and/or testing, if required, will be paid for by the Contractor.

3. If fibers counted by the VPIH/CIH during abatement work inside the regulated area, utilizing the NIOSH 7400 air monitoring method, exceed 0.05 f/cc, the Contractor shall stop work. If fiber levels exceed 0.01 f/cc outside the regulated area, the Contractor shall stop work. The Contractor may request confirmation of the results by analysis of the samples by TEM. Request must be in writing and submitted to the VA's representative. Cost for the confirmation of results will be borne by the Contractor for both the collection and analysis of samples and for the time delay that may/does result for this confirmation. Confirmation sampling and analysis will be the responsibility of the CPIH with review and approval of the VPIH/CIH. An agreement between the CPIH and the VPIH/CIH shall be reached on the exact details of the confirmation effort, in writing, including such things as the number of samples, location, collection, quality control on-site, analytical laboratory, interpretation of results and any follow-up actions. This written agreement shall be co-signed by the IH's and delivered to the VA's representative.

B. SCOPE OF SERVICES OF THE VPIH/CIH CONSULTANT

1. The purpose of the work of the VPIH/CIH is to: assure quality; resolve problems; and prevent the spread of contamination beyond the regulated area. In addition, their work includes performing the final inspection and testing to determine whether the regulated area or building has been adequately decontaminated. All air monitoring is to be done utilizing PCM/TEM. The VPIH/CIH will perform the following tasks:
  - a. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
  - b. Task 2: Perform continuous air monitoring, inspection, and testing outside the regulated area during actual abatement work to detect any faults in the regulated area isolation and any adverse impact on the surroundings from regulated area activities.
  - c. Task 3: Perform unannounced visits to spot check overall compliance of work with contract/specifications. These visits may include any inspection, monitoring, and testing inside and outside the regulated area and all aspects of the operation except personnel monitoring.
  - d. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of unforeseen developments, etc.
  - e. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area or building at the conclusion of the abatement and clean-up work to certify compliance with all regulations and the VA

requirements/specifications.

- f. Task 6: Issue certificate of decontamination for each regulated area or building and project report.
2. All documentation, inspection results and testing results generated by the VPIH/CIH will be available to the Contractor for information and consideration. The Contractor shall cooperate with and support the VPIH/CIH for efficient and smooth performance of their work.
3. The monitoring and inspection results of the VPIH/CIH will be used by the VA to issue any Stop Removal orders to the Contractor during abatement work and to accept or reject a regulated area or building as decontaminated.
4. All air sampling and analysis data will be recorded on VA Form 10-0018.

C. MONITORING, INSPECTION AND TESTING BY CONTRACTOR CPIH

1. The CPIH is responsible for managing all monitoring, inspections, and testing required by these specifications, as well as any and all regulatory requirements adopted by these specifications. The CPIH is responsible for the continuous monitoring of all subsystems and procedures which could affect the health and safety of the Contractor's personnel. Safety and health conditions and the provision of those conditions inside the regulated area for all persons entering the regulated area is the exclusive responsibility of the Contractor /Competent Person. The person performing the personnel and area air monitoring inside the regulated area shall be an IH Technician, who shall be trained and shall have specialized field experience in air sampling and analysis. The IH Technician shall have a NIOSH 582 Course or equivalent and show proof. The IH Technician shall participate in the AIHA Asbestos Analysis Registry or participate in the Proficiency Analytic Testing program of AIHA for fiber counting quality control assurance. The IH Technician shall also be an accredited EPA/State Contractor/Supervisor and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation. The analytic laboratory used by the Abatement Contractor to analyze the samples shall be AIHA accredited for asbestos PAT. A daily log documenting all OSHA requirements for air monitoring for asbestos in 29 CFR 1926.1101(f), (g) and Appendix A. This log shall be made available to the VA representative and the VPIH/CIH. The log will contain, at a minimum, information on personnel or area sampled, other persons represented by the sample, the date of sample collection, start and stop times for sampling, sample volume, flow rate, and fibers/cc. The CPIH shall collect and analyze samples for each representative job being done in the regulated area, i.e., removal, wetting, clean-up, and load-out. No fewer than two personal samples per shift shall be collected and one area sample per 1,000 square feet of regulated area where abatement is taking place and one sample per shift in the clean room area shall be collected. In addition to the continuous monitoring required, the CPIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH responsibilities.

## **2.4 STANDARD OPERATING PROCEDURES**

- A. The Contractor shall have established Standard Operating Procedures (SOP's) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the ways and procedures to be followed during all phases of the work by the contractor's personnel. The SOP's must be modified as needed to address specific requirements of the project. The SOP's shall be submitted for review and approval prior to the start of any abatement work. The minimum topics and areas to be covered by the SOP's are:
1. Minimum Personnel Qualifications
  2. Contingency Plans and Arrangements
  3. Security and Safety Procedures
  4. Respiratory Protection/Personal Protective Equipment Program and Training
  5. Medical Surveillance Program and Recordkeeping
  6. Regulated Area Requirements for Class II work
  7. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
  8. Monitoring, Inspections, and Testing
  9. Removal Procedures for Class II Materials
  10. Disposal of ACM Waste
  11. Regulated Area Decontamination/Clean-up
  12. Regulated Area Visual and Air Clearance
  13. Project Completion/Closeout

## **2.5 SUBMITTALS**

- A. PRE-start MEETING SUBMITTALS
1. Submit to the VA a minimum of 14 days prior to the pre-start meeting the following for review and approval. Meeting this requirement is a prerequisite for the pre-start meeting for this project.
  2. Submit a detailed work schedule for the entire project reflecting contract documents and the phasing/schedule requirements from the CPM chart.
  3. Submit a staff organization chart showing all personnel who will be working on the project and their capacity/function. Provide their qualifications, training, accreditations, and licenses, as appropriate. Provide a copy of the "Certificate of Worker's Acknowledgment" and the "Affidavit of Medical Surveillance and Respiratory Protection" for each person.
  4. Submit Standard Operating Procedures developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH.
  5. Submit the specifics of the materials and equipment to be used for this project with brand names, model numbers, performance

- characteristics, pictures/diagrams, and number available for the following:
- a. HEPA vacuums, air monitoring pumps, calibration devices, infrared heating machines, and emergency power generating system.
  - b. Encapsulants, surfactants, hand held sprayers, airless sprayers, fire extinguishers.
  - c. Personal protective equipment.
  - d. Fire safety equipment to be used in the regulated area.
6. Submit the name, location, and phone number of the approved landfill; proof/verification the landfill is approved for ACM disposal; the landfill's requirements for ACM waste; the type of vehicle to be used for transportation; and name, address, and phone number of subcontractor, if used. Proof of asbestos training for transportation personnel shall be provided.
  7. Submit required notifications and arrangements made with regulatory agencies having regulatory jurisdiction and the specific contingency/emergency arrangements made with local health, fire, ambulance, hospital authorities and any other notifications/arrangements.
  8. Submit the name, location and verification of the laboratory and/or personnel to be used for analysis of air and/or bulk samples. Air monitoring must be done in accordance with OSHA 29 CFR 1926.1101(f) and Appendix A.
  9. Submit qualifications verification: Submit the following evidence of qualifications. Make sure that all references are current and verifiable by providing current phone numbers and documentation.
    - a. Asbestos Abatement Company: Project experience within the past 3 years; listing projects first most similar to this project:
      - 1) Project Name; Type of Abatement; Duration; Cost; Reference Name/Phone Number; Final Clearance; Completion Date
    - b. List of project(s) halted by owner, A/E, IH, regulatory agency in the last 3 years:
      - 1) Project Name; Reason; Date; Reference Name/Number; Resolution
    - c. List asbestos regulatory citations, penalties, damages paid and legal actions taken against the company in the last 3 years. Provide copies and all information needed for verification.
  10. Submit information on personnel: Provide a resume; address each item completely; provide references; phone numbers; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH stating that all personnel submitted below have medical records in accordance with OSHA 29 CFR 1926.1101(m) and 29 CFR 1910.20 and that the company has implemented a medical surveillance program and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
  11. CPIH: Name; years of abatement experience; list of projects similar to this one; certificates, licenses, accreditations for proof of

- AHERA/OSHA specialized asbestos training; professional affiliations; number of workers trained; samples of training materials; samples of SOP's developed; medical opinion; current respirator fit test.
- a. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person/Supervisor; list of similar projects as Competent Person/Supervisor; as a worker; certificates, licenses, accreditations; proof of AHERA/OSHA specialized asbestos training; maximum number of personnel supervised on a project; medical opinion; current respirator fit test.
  - b. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses in asbestos abatement and respiratory protection; medical opinion; current respirator fit test.
12. Submit copies of State license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain english the coverage provided and the fact that asbestos abatement activities are covered by the policy; copy of SOP's incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who does and how is air monitoring conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; copies of monitoring results of the five referenced projects listed and analytical method(s) used.
  13. When rental equipment is to be used in regulated areas or used to transport asbestos waste, the contractor shall assure complete decontamination of the rental equipment before return to the rental agency.

B. SUBMITTALS DURING ABATEMENT

1. The Competent Person shall maintain and submit a daily log at the regulated area documenting the dates and times of the following: purpose, attendees and summary of meetings; all personnel entering/exiting the regulated area; document and discuss the resolution of unusual events such as critical barrier breeching, equipment failures, emergencies, and any cause for stopping work; representative air monitoring and results/TWA's/EL's. Submit this daily log to VA's representative.
2. The CPIH shall document and maintain the following during abatement and submit as appropriate to the VA's representative.
  - a. Inspection and approval of the regulated area preparation prior to start of work and daily during work.
  - b. Removal of any poly critical/floor barriers.
  - c. Visual inspection/testing by the CPIH.
  - d. Packaging and removal of ACM waste from regulated area.
  - e. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

C. SUBMITTALS AT COMPLETION OF ABATEMENT

1. The CPIH shall submit a project report consisting of the daily log book requirements and documentation of events during the abatement project including Waste Shipment Records signed by the landfill's agent. The report shall include a certificate of completion, signed and dated by the CPIH, in accordance with Attachment #1. The VA Representative will forward the abatement report to the Medical Center after completion of the project.

**PART 3 - EXECUTION**

**3.1 PRE-ABATEMENT ACTIVITIES**

A. PRE-ABATEMENT MEETING

1. The VA representative, upon receipt, review, and substantial approval of all pre-abatement submittals and verification by the CPIH that all materials and equipment required for the project are on the site, will arrange for a pre-abatement meeting between the Contractor, the CPIH, Competent Person(s), the VA representative(s), and the VPIH/CIH. The purpose of the meeting is to discuss any aspect of the submittals needing clarification or amplification and to discuss any aspect of the project execution and the sequence of the operation. The Contractor shall be prepared to provide any supplemental information/documentation to the VA's representative regarding any submittals, documentation, materials or equipment. Upon satisfactory resolution of any outstanding issues, the VA's representative will issue a written order to proceed to the Contractor. No abatement work of any kind described in the following provisions shall be initiated prior to the VA written order to proceed.

B. PRE-ABATEMENT INSPECTIONS AND PREPARATIONS

1. Before any work begins on the construction of the regulated area, the Contractor will:
2. Conduct a space-by-space inspection with an authorized VA representative and prepare a written inventory of all existing damage in those spaces where asbestos abatement will occur. Still or video photography may be used to supplement the written damage inventory. Document will be signed and certified as accurate by both parties.
3. The VA Representative, the Contractor, and the VPIH/CIH must be aware of 10/95 A/E Quality Alert indicating the failure to identify asbestos as applicable to glovebag abatement in the areas listed. Make sure these areas are looked at/reviewed on the project:
4. Steam line trench coverings.
5. If applicable, ensure that all machinery, and other movable objects which the Contractor is required to remove from the regulated area have been cleaned and removed or properly protected from contamination.
6. Shut down and lock out in accordance with 29 CFR 1910.147 all electrical circuits which pose a potential hazard. Electrical

arrangements will be tailored to the particular regulated area and the systems involved. All electrical circuits affected will be turned off at the circuit box outside the regulated area, not just the wall switch. The goal is to eliminate the potential for electrical shock which is a major threat to life in the regulated area due to water use and possible energized circuits. Electrical lines used to power equipment in the regulated area shall conform to all electrical safety standards and shall be isolated by the use of a ground fault circuit interrupter (GFCI). All GFCI shall be tested prior to use. The VA's representative will monitor the electrical shutdown.

C. PRE-ABATEMENT CONSTRUCTION AND OPERATIONS

1. Perform all preparatory work for the first regulated area in accordance with the approved work schedule and with this specification.
2. Upon completion of all preparatory work, the CPIH will inspect the work and systems and will notify the VA's representative when the work is completed in accordance with this specification. The VA's representative may inspect the regulated area and the systems with the VPIH/CIH and may require that upon satisfactory inspection, Contractor's employees perform all major aspects of the approved SOP's, especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation.
3. The CPIH shall document the pre-abatement activities described above and deliver a copy to the VA's representative.
4. Upon satisfactory inspection of the installation of and operation of systems the VA's representative will notify the Contractor in writing to proceed with the Class II asbestos abatement work in accordance with this specification.

**3.2 REGULATED AREA PREPARATIONS**

A. OSHA DANGER SIGNS

1. Place caution tape to establish regulated work area. Post OSHA DANGER signs meeting the specifications of OSHA 29 CFR 1926.1101 (8CCR1529 Section n), at any location and approaches to the regulated area where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the regulated area to permit any personnel to read the sign and take the necessary measures to avoid exposure. Additional signs will be posted following construction of the regulated area enclosure.

B. SHUT DOWN - LOCK OUT ELECTRICAL

1. Shut down and lock out electric power to the regulated area. Provide temporary power and lighting. Insure safe installation including GFCI of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.

C. SHUT DOWN - LOCK OUT HVAC

1. Shut down and lock out heating, cooling, and air conditioning system (HVAC) components that are in, supply or pass through the regulated area. Investigate the regulated area and agree on pre-abatement condition with the VA's representative. Seal all intake and exhaust vents in the regulated area with duct tape and 2 layers of 6-mil poly. Also, seal any seams in system components that pass through the regulated area. Remove all contaminated HVAC system filters and place in labeled 6 mil poly disposal bags for disposal as asbestos waste.

D. SANITARY FACILITIES

1. The Contractor shall provide sanitary facilities for abatement personnel and maintain them in a clean and sanitary condition throughout the abatement project.

E. WATER FOR ABATEMENT

1. The VA will provide water for abatement purposes. The Contractor shall connect to the existing VA system. The service to the shower(s) shall be supplied with backflow prevention.

F. PRE-CLEANING MOVABLE OBJECTS

1. Pre-clean all movable objects within the regulated area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the regulated area and carefully stored in an uncontaminated location.

G. PRE-CLEANING FIXED OBJECTS

1. Pre-clean all fixed objects in the regulated area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Contact the manufacturer for special protection requirements.

H. PRE-CLEANING SURFACES IN THE REGULATED AREA

1. Pre-clean all surfaces in the regulated area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos-containing materials during this pre-cleaning phase.

**3.3 CONTAINMENT BARRIERS AND COVERINGS FOR THE REGULATED AREA**

A. GENERAL

1. This work is assumed to take place outdoors within a regulated area and glove bag procedures will be conducted inside the utility trench, once the trench is made accessible. Should the adjacent area past the regulated area become contaminated due to improper work activities, the Contractor shall suspend work inside the regulated area, continue wetting. Any and all costs associated with the adjacent area cleanup shall not be borne by the VA.



B. PREPARATION PRIOR TO SEALING OFF

1. Place all materials, equipment and supplies necessary to isolate the regulated area inside the regulated area. Remove all movable material/equipment as described above and secure all unmovable material/equipment as described above. Properly secured material/equipment shall be considered to be outside the regulated area.

C. CONTROLLING ACCESS TO THE REGULATED AREA

1. Access to the regulated area shall be permitted only by the competent person. All other means of access shall be closed off by proper sealing and OSHA DANGER demarcation signs posted on the clean side of the regulated area where it is adjacent to or within view of any occupiable area. An opaque visual barrier of 6 mil poly should be provided so that the abatement work is not visible to VA occupants. If the area adjacent to the regulated area is accessible to the public, construct a solid barrier on the public side of the sheeting for protection and isolation of the project. The barrier shall be constructed with normal 2" x 4" (50mm x 100mm) wood or metal studs 16" (400mm) on centers, securely anchored to prevent movement and covered with a minimum of 1/2" (12.5mm) plywood. Any alternative method must be given a written approval by the VA's representative.

D. CRITICAL BARRIERS

1. Not applicable for outdoor work.

**3.4 REMOVAL OF CLASS II MATERIALS (TAR PAPER JACKETING):**

A. GENERAL

1. All applicable requirements of OSHA, EPA, and DOT shall be followed during Class II work. Keep materials intact; do not disturb; wet while working with it; wrap as soon as possible with 2 layers of 6 mil plastic for disposal.

B. REMOVAL OF TAR PAPER:

1. All Tar Paper must be wetted prior to removal. Keep Tar Paper Intact, whenever possible.
2. All waste must be wrapped in two layers of 6mil poly and removed carefully from the trench.

**3.5 DISPOSAL OF CLASS II WASTE MATERIAL:**

A. GENERAL

1. Package and dispose of waste materials as per this specification. All OSHA, EPA, and DOT requirements must be met. Landfill requirements for packaging must also be met. Disposal of non-friable waste must be done in accordance with applicable regulations.

### **3.6 PROJECT DECONTAMINATION**

#### **A. GENERAL**

1. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH.
2. If the asbestos abatement work is in an area which was contaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal and cleaning of the regulated area surfaces after the primary barrier removal.
3. If the asbestos abatement work is in an area which was uncontaminated prior to the start of abatement, the decontamination will be done by cleaning the primary barrier poly prior to its removal, thus preventing contamination of the building when the regulated area critical barriers are removed.

#### **B. REGULATED AREA CLEARANCE**

1. Air testing and other requirements which must be met before release of the Contractor and re-occupancy of the regulated area space are specified in Final Testing Procedures.

#### **C. WORK DESCRIPTION**

1. Decontamination includes the cleaning and clearance of the air in the regulated area and the decontamination and removal of the enclosures/facilities installed prior to the abatement work including primary/critical barriers, PDF and W/EDF facilities.

#### **D. PRE-DECONTAMINATION CONDITIONS**

1. Before decontamination starts, all ACM waste from the regulated area shall be removed, all waste collected and removed, and the secondary barrier of poly removal and disposed of along with any gross debris generated by the work.
2. At the start of decontamination, the following shall be in place:
  - a. Critical barriers over all openings consisting of two layers of 6 mil poly which is the sole barrier between the regulated area and the rest of the building or outside.
  - b. Decontamination facilities, if required for personnel and equipment in operating condition.

#### **E. CLEANING:**

1. Clean all surfaces of the regulated area by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping methods. If determined by the CPIH/VPIH/CIH additional cleaning(s) may be needed.

### **3.7 VISUAL INSPECTION AND AIR CLEARANCE TESTING**

#### **A. GENERAL**

1. Notify the VA representative 24 hours in advance for the performance of the final visual inspection and testing. The final visual inspection and testing will be performed by the VPIH/CIH after the

cleaning.

B. VISUAL INSPECTION

1. Final visual inspection will include the entire regulated area, all poly sheeting, seals over openings, and any other openings. If any debris, residue, dust or any other suspect material is detected, the cleaning shall be repeated at no cost to the VA. Dust/ material samples may be collected and analyzed at no cost to the VA at the discretion of the VPIH/CIH to confirm visual findings. When the regulated area is visually clean the final testing can be done.

C. CLEARANCE VISUALS

1. An acceptable final visual inspection by the VPIH/CIH and VA Representative will be required. Perimeter air samples will be collected during the work and analyzed in accordance with procedures for PCM in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures. Additional inspection and testing will be done at the expense of the Contractor.
2. If the results of the visual inspection are acceptable, remove the critical barriers. Any small quantities of residue material found upon removal of the poly shall be removed with a HEPA vacuum and localized isolation. If significant quantities are found as determined by the VPIH/CIH, then the entire area affected shall be cleaned as specified in the final cleaning.
3. If release criteria are met, proceed to perform the abatement closeout and to issue the certificate of completion in accordance with these specifications.

D. FINAL AIR CLEARANCE PROCEDURES

1. Not applicable for outdoor work.

**3.8 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE**

A. COMPLETION OF ABATEMENT WORK

1. After thorough decontamination, complete asbestos abatement work upon meeting the regulated area clearance criteria and fulfilling the following:
  - a. Remove all equipment, materials, and debris from the project area.
  - b. Package and dispose of all asbestos waste as required.
  - c. Fulfill other project closeout requirements as specified elsewhere in this specification.

B. CERTIFICATE OF COMPLETION BY CONTRACTOR

1. The CPIH shall complete and sign the "Certificate of Completion" in accordance with Attachment 1 at the completion of the abatement and decontamination of the regulated area.

C. WORK SHIFTS

1. All work shall be done during administrative hours (8:00 AM to 4:30 PM) Monday - Friday excluding Federal Holidays. Any change in the work schedule must be approved in writing by the VA Representative.

ATTACHMENT #1

CERTIFICATE OF COMPLETION

DATE:

PROJECT NAME:

VAMC/ADDRESS:

1. I certify that I have personally inspected, monitored and supervised the abatement work of (specify regulated area or Building):  
which took place from        /        /        to        /        /
2. That throughout the work all applicable requirements/regulations and the VA's specifications were met.
3. That any person who entered the regulated area was protected with the appropriate personal protective equipment and respirator and that they followed the proper entry and exit procedures and the proper operating procedures for the duration of the work.
4. That all employees of the Abatement Contractor engaged in this work were trained in respiratory protection, were experienced with abatement work, had proper medical surveillance documentation, were fit-tested for their respirator, and were not exposed at any time during the work to asbestos without the benefit of appropriate respiratory protection.
5. That I performed and supervised all inspection and testing specified and required by applicable regulations and VA specifications.
6. That the conditions inside the regulated area were always maintained in a safe and healthy condition and the maximum fiber count never exceeded 0.5 f/cc, except as described below.
7. That all glovebag work was done in accordance with OSHA requirements and the manufacturer's recommendations.

CPIH Name:

Signature/Date:

Asbestos Abatement Contractor's Name:

Signature/Date:

ATTACHMENT #2

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME:

DATE:

PROJECT ADDRESS:

ABATEMENT CONTRACTOR'S NAME:

WORKING WITH ASBESTOS CAN BE HAZARDOUS TO YOUR HEALTH. INHALING ASBESTOS HAS BEEN LINKED WITH VARIOUS TYPES OF CANCERS. IF YOU SMOKE AND INHALE ASBESTOS FIBERS YOUR CHANCES OF DEVELOPING LUNG CANCER IS GREATER THAN THAT OF THE NON-SMOKING PUBLIC.

Your employer's contract with the owner for the above project requires that: You must be supplied with the proper personal protective equipment including an adequate respirator and be trained in its use. You must be trained in safe and healthy work practices and in the use of the equipment found at an asbestos abatement project. You must receive/have a current medical examination for working with asbestos. These things shall be provided at no cost to you. By signing this certificate you are indicating to the owner that your employer has met these obligations.

RESPIRATORY PROTECTION: I have been trained in the proper use of respirators and have been informed of the type of respirator to be used on the above indicated project. I have a copy of the written Respiratory Protection Program issued by my employer. I have been provided for my exclusive use, at no cost, with a respirator to be used on the above indicated project.

TRAINING COURSE: I have been trained by a third party, State/EPA accredited trainer in the requirements for an AHERA/OSHA Asbestos Abatement Worker training course, 32 hours minimum duration. I currently have a valid State accreditation certificate. The topics covered in the course include, as a minimum, the following:

- Physical Characteristics and Background Information on Asbestos
- Potential Health Effects Related to Exposure to Asbestos
- Employee Personal Protective Equipment
- Establishment of a Respiratory Protection Program
- State of the Art Work Practices
- Personal Hygiene
- Additional Safety Hazards
- Medical Monitoring
- Air Monitoring
- Relevant Federal, State and Local Regulatory Requirements, Procedures, and Standards
- Asbestos Waste Disposal

MEDICAL EXAMINATION: I have had a medical examination within the past 12 months which was paid for by my employer. This examination included: health history, occupational history, pulmonary function test, and may have included a chest x-ray evaluation. The physician issued a positive written opinion after the examination.

Signature:

Printed Name:

Social Security Number:

Witness:

ATTACHMENT #3

AFFIDAVIT OF MEDICAL SURVEILLANCE, RESPIRATORY PROTECTION AND  
TRAINING/ACCREDITATION

VA PROJECT NAME AND NUMBER:

VA MEDICAL FACILITY:

ABATEMENT CONTRACTOR'S NAME AND ADDRESS:

1. I verify that the following individual

Name: Social Security Number:

who is proposed to be employed in asbestos abatement work associated with the above project by the named Abatement Contractor, is included in a medical surveillance program in accordance with 29 CFR 1926.1101(m), and that complete records of the medical surveillance program as required by 29 CFR 1926.1101(m) (n) and 29 CFR 1910.20 are kept at the offices of the Abatement Contractor at the following address.

Address:

2. I verify that this individual has been trained, fit-tested and instructed in the use of all appropriate respiratory protection systems and that the person is capable of working in safe and healthy manner as expected and required in the expected work environment of this project.
3. I verify that this individual has been trained as required by 29 CFR 1926.1101(k). This individual has also obtained a valid State accreditation certificate. Documentation will be kept on-site.
4. I verify that I meet the minimum qualifications criteria of the VA specifications for a CPIH.

Signature of CPIH:

Date:

Printed Name of CPIH:

Signature of Contractor:

Date:

Printed Name of Contractor:

ABATEMENT CONTRACTOR/COMPETENT PERSON(S) REVIEW AND ACCEPTANCE OF THE VA'S  
ASBESTOS SPECIFICATIONS

VA Project Location:

VA Project #:

VA Project Description:

This form shall be signed by the Asbestos Abatement Contractor Owner and the Asbestos Abatement Contractor's Competent Person(s) prior to any start of work at the VA related to this Specification. If the Asbestos Abatement Contractor's/Competent Person(s) has not signed this form, they shall not be allowed to work on-site.

I, the undersigned, have read VA's Asbestos Specification regarding the asbestos abatement requirements. I understand the requirements of the VA's Asbestos Specification and agree to follow these requirements as well as all required rules and regulations of OSHA/EPA/DOT and State/Local requirements. I have been given ample opportunity to read the VA's Asbestos Specification and have been given an opportunity to ask any questions regarding the content and have received a response related to those questions. I do not have any further questions regarding the content, intent and requirements of the VA's Asbestos Specification.

At the conclusion of the asbestos abatement, I will certify that all asbestos abatement work was done in accordance with the VA's Asbestos Specification and all ACM was removed properly and no fibrous residue remains on any abated surfaces.

Abatement Contractor Owner's Signature \_\_\_\_\_ Date \_\_\_\_\_

Abatement Contractor Competent Person(s)	Date
--	------

Date

Date

- - - E N D - - -





**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies cast-in-place structural concrete and materials and mixes for other concrete.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 07 19 00, WATER REPELLENTS
- D. Section 07 26 13.13, CONCRETE SLAB APPLIED VAPOR RETARDER
- E. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- F. Concrete roads, walks, and similar exterior site work: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

**1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN:**

- A. Testing agency retained and reimbursed by the Contractor and approved by Resident Engineer.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology. Accompany request for approval of testing agency with a copy of Report of Latest Inspection of Laboratory Facilities by CCRL.
- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

**1.4 TOLERANCES:**

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).
- B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than

3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.

- C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and - 6 mm (-1/4 inch). Tolerance of thickness of beams more than 300 mm (12 inch) but less than 900 mm (3 feet) is +20 mm (+3/4 inch) and -10 mm (-3/8 inch).
- D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155, except as follows:
  - 1. Test entire slab surface, including those areas within 600 mm (2 feet) of construction joints and vertical elements that project through slab surface.
  - 2. Maximum elevation change which may occur within 600 mm (2 feet) of any column or wall element is 6 mm (0.25 inches).
  - 3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 1500 mm (5 feet).

#### **1.5 REGULATORY REQUIREMENTS:**

- A. ACI SP-66 - ACI Detailing Manual.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 301 - Standard Specifications for Structural Concrete.

#### **1.6 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings: Reinforcing steel: Complete shop drawings. Comply with requirements of ACI SP-66. Include bar sizes, material types, lengths, spacings, locations, and quantities of reinforcing steel; bar schedules, stirrup spacing, shapes of bent bars, spacing of bars, and types and location of splices. Include special reinforcement required at openings and flat slab shear reinforcing. Do not reproduce construction documents for shop drawings.
- C. Shoring Drawings: All shoring and re-shoring drawings are to be prepared by, signed and sealed by a professional engineer registered in the State of California.
- D. Mill Test Reports:
  - 1. Reinforcing Steel.
  - 2. Cement.
- E. Manufacturer's Certificates:
  - 1. Cement
  - 2. Aggregate

3. Lightweight aggregate for structural concrete.
  4. Air-entraining admixture.
  5. Chemical admixtures, including chloride ion content.
  6. Waterproof paper for curing concrete.
  7. Liquid membrane-forming compounds for curing concrete.
  8. Non-shrink grout.
  9. Liquid hardener.
  10. Waterstops.
  11. Expansion joint filler.
  12. Adhesive binder.
  13. Color pigments
  14. Vapor Barrier
- F. Product Data:
1. Mechanical Couplers
  2. T-Headed Reinforcement
- G. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- H. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.
- I. Concrete Mix Design: Submit for each type and strength of concrete.
1. Include unit weight, slump, water cement fly ash ratio curves, concrete mix ingredients, admixtures and compression test reports. Results of testing or test data used to establish mix proportions are to be provided for each mix design. Include shrinkage test data for mix designs.
  2. Mix designs to be prepared, stamped and signed by a Professional Engineer registered in the State of California.
- J. Shoring and Reshoring Sequence: Submit for approval a shoring and reshoring sequence for flat slab/flat plate portions, prepared by a registered Professional Engineer. As a minimum, include timing of form stripping, reshoring, number of floors to be re-shored and timing of re-shore removal

to serve as an initial outline of procedures subject to modification as construction progresses. Submit revisions to sequence, whether initiated by Resident Engineer (see FORMWORK) or Contractor.

- K. Construction joints: Submit plans showing proposed construction joint locations. The maximum spacing of joints is to be as indicated in the typical details.

#### **1.7 DELIVERY, STORAGE, AND HANDLING:**

- A. Conform to ACI 304. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.
- B. Deliver cement in original sealed containers bearing name of brand and manufacturer, and marked with net weight of contents. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Store bulk cement and fly ash in separate suitable bins.
- C. Deliver other packaged materials for use in concrete in original sealed containers, plainly marked with manufacturer's name and brand, and protect from damage until used.
- D. Store reinforcement in a manner that will prevent rusting or coating with grease, oil, dirt, and other objectionable material.
- E. Deliver reinforcement to the job site bundled, tagged and marked using metal tags.

#### **1.8 PRE-CONCRETE CONFERENCE:**

- A. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
- B. Agenda: Includes but is not limited to:
  - 1. Submittals.
  - 2. Coordination of work.
  - 3. Availability of material.
  - 4. Concrete mix design including admixtures.
  - 5. Methods of placing, finishing, and curing.
  - 6. Finish criteria required to obtain required flatness and levelness.
  - 7. Timing of floor finish measurements.
  - 8. Material inspection and testing.
- C. Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; admixture manufacturers; Resident Engineer; Consulting Engineer; Department of Veterans Affairs retained testing laboratories for concrete testing and finish (F-number) verification.

- D. Minutes of the meeting: Contractor shall take minutes and type and distribute the minutes to attendees within five days of the meeting.

**1.9 MOCK-UP:**

- A. In addition to the other specified samples and tests, construct a mock-up using the materials, reinforcing, forming system and construction methods proposed for use in exposed architectural concrete.
- B. Construct the mock-up with at least a 1.25 m by 2.5 m (4 feet by 8 feet) exposed surface and suitable foundations. Include the following where applicable: Control joints, reglets, recesses or other typical architectural details.
- C. Before casting the mock-up, submit full detailed Shop Drawings of the mock-up formwork for review by the Architect. Perform all necessary preliminary tests to ensure that concrete used for the mock-up will exactly match the approved sample in color and texture.
- D. Perform the surface treatment proposed for use on one or more areas not less than 300 mm by 300 mm (1 foot by 1 foot) on the back side of the mock-up to establish the texture of finish required by the Architect. Repeat as required until a sample satisfactory to the Architect has been obtained.
- E. Treat the finished front surface of the mock-up to produce a uniform appearance similar in every respect to the approved sample area.
- F. The completed mock-up shall be inspected by the Architect. Failure of the mock-up to match the approved sample will require the construction of further mock-ups until approval is obtained. Remove rejected mock-ups immediately.
- G. Maintain the approved mock-ups in good condition at the job site until all architectural concrete surfaces have been completed and approved by the Architect. Remove the mock-up from the site after completion of the above.

**1.10 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
  - 1. 117-10 Tolerances for Concrete Construction and Materials
  - 2. 211.1-91(R2009) Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 3. 211.2-98(R2004) Selecting Proportions for Structural Lightweight Concrete
  - 4. 214R-02 Evaluation of Strength Test Results of Concrete
  - 5. 301-10 Structural Concrete
  - 6. 304R-00(R2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete

7. 305R-10 Hot Weather Concreting
  8. 306R-10 Cold Weather Concreting
  9. 308R-01(R2008) Standard Practice for Curing Concrete
  10. 309R-05 Guide for Consolidation of Concrete
  11. 318-08 Building Code Requirements for Reinforced Concrete and Commentary
  12. 347-04 Guide to Formwork for Concrete
  13. SP-66-04 ACI Detailing Manual
- C. American National Standards Institute and American Hardboard Association (ANSI/AHA):
1. A135.4-2004 Basic Hardboard
- D. American Society for Testing and Materials (ASTM):
1. A82/A82M-07 Steel Wire, Plain, for Concrete Reinforcement
  2. A185/185M-07 Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  3. A615/A615M-09 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  4. A653/A653M-09 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  5. A706/A706M-09 Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
  6. A767/A767M-09 Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
  7. A775/A775M-07 Epoxy-Coated Reinforcing Steel Bars
  8. A820-06 Steel Fibers for Fiber-Reinforced Concrete
  9. A996/A996M-09 Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
  10. C31/C31M-09 Making and Curing Concrete Test Specimens in the field
  11. C33-08 Concrete Aggregates
  12. C39/C39M-09 Compressive Strength of Cylindrical Concrete Specimens
  13. C94/C94M-09 Ready-Mixed Concrete
  14. C143/C143M-10 Slump of Hydraulic Cement Concrete
  15. C150-09 Portland Cement
  16. C171-07 Sheet Materials for Curing Concrete
  17. C172-08 Sampling Freshly Mixed Concrete
  18. C173-10... Air Content of Freshly Mixed Concrete by the Volumetric Method
  19. C192/C192M-07 Making and Curing Concrete Test Specimens in the Laboratory

20. C231-09 Air Content of Freshly Mixed Concrete by the Pressure Method
  21. C260-06 Air-Entraining Admixtures for Concrete
  22. C309-07 Liquid Membrane-Forming Compounds for Curing Concrete
  23. C330-09 Lightweight Aggregates for Structural Concrete
  24. C494/C494M-10 Chemical Admixtures for Concrete
  25. C496-06 Splitting Tensile Strength of Cylindrical Concrete Specimens
  26. C567-05 Density of Structural Lightweight Concrete
  27. C618-08 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
  28. C666/C666M-03 Resistance of Concrete to Rapid Freezing and Thawing
  29. C881/C881M-02 Epoxy-Resin-Base Bonding Systems for Concrete
  30. C1107/1107M-08 Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
  31. C1315-08 Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
  32. D6-95(R2006) Loss on Heating of Oil and Asphaltic Compounds
  33. D297-93(R2006) Rubber Products-Chemical Analysis
  34. D1751-04(R2008) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
  35. D4397-09 Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
  36. E1155-96(R2008) Determining  $F_F$  Floor Flatness and  $F_L$  Floor Levelness Numbers
- E. American Welding Society (AWS):
1. D1.4M-11 Structural Welding Code - Reinforcing Steel
- F. Concrete Reinforcing Steel Institute (CRSI):
1. Handbook 2008
- G. National Cooperative Highway Research Program (NCHRP):
1. Report On Concrete Sealers for the Protection of Bridge Structures
- H. U. S. Department of Commerce Product Standard (PS):
1. PS 1 Construction and Industrial Plywood
  2. PS 20 American Softwood Lumber
- I. U. S. Army Corps of Engineers Handbook for Concrete and Cement:
1. CRD C513 Rubber Waterstops

2. CRD C572 Polyvinyl Chloride Waterstops

## **PART 2 - PRODUCTS**

### **2.1 FORMS:**

- A. Wood: PS 20 free from loose knots and suitable to facilitate finishing concrete surface specified; tongue and grooved.
- B. Plywood: PS-1 Exterior Grade B-B (concrete-form) 16 mm (5/8 inch), or 20 mm (3/4 inch) thick for unlined contact form. B-B High Density Concrete Form Overlay optional.
- C. Corrugated Fiberboard Void Boxes: Double faced, completely impregnated with paraffin and laminated with moisture resistant adhesive, size as shown. Design forms to support not less than 48 KPa (1000 psf) and not lose more than 15 percent of their original strength after being completely submerged in water for 24 hours and then air dried.
- D. Form Lining:
  - 1. Hardboard: ANSI/AHA A135.4, Class 2 with one (S1S) smooth side)
  - 2. Plywood: Grade B-B Exterior (concrete-form) not less than 6 mm (1/4 inch) thick.
  - 3. Plastic, fiberglass, or elastomeric capable of reproducing the desired pattern or texture.
- E. Form Ties: Develop a minimum working strength of 13.35 kN (3000 pounds) when fully assembled. Ties shall be adjustable in length to permit tightening of forms and not have any lugs, cones, washers to act as spreader within form, nor leave a hole larger than 20 mm (3/4 inch) diameter, or a depression in exposed concrete surface, or leave metal closer than 40 mm (1 1/2 inches) to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted.

### **2.2 MATERIALS:**

- A. Portland Cement: ASTM C150 Type I or II. Acquire all cement for entire project from the same source.
- B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalies, and loss on ignition (LOI) not to exceed 5 percent.
- C. Coarse Aggregate: ASTM C33.
  - 1. Size 67 or Size 467 may be used for footings and walls over 300 mm (12 inches) thick.
  - 2. Coarse aggregate for applied topping, encasement of steel columns, and metal pan stair fill shall be Size 7.



3. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourth of minimum clear spacing between reinforcing bars.
  4. Acquire all aggregates for entire project from the same source.
  5. Cleanliness not to be less than 75 when tested in accordance with California Test 227
- D. Lightweight Aggregates for Structural Concrete: ASTM C330, Table 1. Maximum size of aggregate not larger than one-fifth of narrowest dimension between forms, nor three-fourth of minimum clear distance between reinforcing bars. Contractor to furnish certified report to verify that aggregate is sound and durable, and has a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666.
1. Course aggregate to be rotary kiln-expanded shale or clay having surface scaled by firing
  2. Fine aggregate to be a blend of natural sand and lightweight fines.
- E. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a 4.75 mm (No. 4) sieve, 10 percent maximum shall pass a 150  $\mu$ m (No. 100) sieve.
1. Acquire all aggregates for entire project from the same source.
  2. Cleanliness not to be less than 75 when tested in accordance with California Test 217.
- F. Mixing Water: Fresh, clean, and potable.
- G. Admixtures:
1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
  2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
  3. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.
  4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
  5. Air Entraining Admixture: ASTM C260.
  6. Calcium Nitrite corrosion inhibitor: ASTM C494 Type C.
  7. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.
  8. Certification: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.

- H. Vapor Barrier: ASTM E1745, Class A, 0.38 mm (15 mil) or greater.
  - 1. Multi-layer plastic extrusion or equivalent, stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs.
  - 2. Permeance of less than 0.01 Perms [grains/(ft<sup>2</sup> · hr · inHg)] as tested in accordance with ASTM E 1745 Section 7. Provide independent testing data showing compliance.
  - 3. Single ply polyethylene is prohibited.
- I. Reinforcing Steel #7 bars and smaller: ASTM A615, or ASTM A996, deformed, grade as indicated on the drawings.
- J. Reinforcing Steel, #8 and larger and all bars to be welded: ASTM A706, deformed, grade as indicated on drawings. Permitted for bars #7 and smaller.
- K. Welded Wire Fabric: ASTM A185.
- L. Galvanized Reinforcing Bars: ASTM A767.
- M. Epoxy Coated Reinforcing Bars: ASTM A775.
- N. Cold Drawn Steel Wire: ASTM A82.
- O. Reinforcement for Metal Pan Stair Fill: 50 mm (2 inch) wire mesh, either hexagonal mesh at .8Kg/m<sup>2</sup> (1.5 pounds per square yard), or square mesh at .6Kg/m<sup>2</sup> (1.17 pounds per square yard).
- P. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.
- Q. Expansion Joint Filler: ASTM D1751.
- R. Sheet Materials for Curing Concrete: ASTM C171.
- S. Liquid Membrane-forming Compounds for Curing Concrete: ASTM C309, Type I, with fugitive dye. Compound shall be compatible with scheduled surface treatment, such as paint and resilient tile, and shall not discolor concrete surface.
- T. Abrasive Aggregate: Aluminum oxide grains or emery grits.
- U. Liquid Hardener and Dustproofer: Fluosilicate solution of magnesium fluosilicate or zinc fluosilicate. Magnesium and zinc may be used separately or in combination as recommended by manufacturer.
- V. Moisture Vapor Emissions & Alkalinity Control Sealer: 100% active colorless aqueous silicate solution concrete surface treatment applied the day of the concrete pour in lieu of other curing methods for all concrete slabs receiving resilient flooring, such as, sheet vinyl, vinyl composition tile, rubber, wood flooring, carpet, epoxy coatings and overlays.

1. ASTM C1315 Type 1 Class A, and ASTM C309 Type 1 Class A, penetrating product to have no less than 34% solid content, leaving no sheen, volatile organic compound (VOC) content rating as required to suite regulatory requirements. The product shall have at least a five (5) year documented history in controlling moisture vapor emission from damaging floor covering, compatible with all finish materials.
  2. MVE 15-Year Warranty:
    - a. When a floor covering is installed on a below grade, on grade, or above grade concrete slab treated with Moisture Vapor Emissions & Alkalinity Control Sealer according to manufacturer's instruction, sealer manufacturer shall warrant the floor covering system against failure due to moisture vapor migration or moisture-born contaminates for a period of fifteen (15) years from the date of original installation. The warranty shall cover all labor and materials needed to replace all floor covering that fails due to moisture vapor emission & moisture born contaminates.
- W. Penetrating Sealer: For use on parking garage ramps and decks. High penetration silane sealer providing minimum 95 percent screening per National Cooperative Highway Research Program (NCHRP) No. 244 standards for chloride ion penetration resistance. Requires moist (non-membrane) curing of slab.
- X. Non-Shrink Grout:
1. ASTM C1107, pre-mixed, consisting of non-metallic aggregate, cement, water, and plasticizing agents. Produce a compressive strength of at least 17 MPa (2400 psi) at three days and 48 MPa (7000 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 1200 mm x 1200 mm (4 foot by 4 foot) base plate.
  2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under an 450 mm x 900 mm (18 inch by 36 inch) base plate.
- Y. Adhesive Binder: ASTM C881.
- Z. Polyvinyl Chloride Waterstop: CRD C572.
- AA. Rubber Waterstops: CRD C513.
- BB. Porous Backfill: Crushed stone or gravel graded from 25 mm to 20 mm (1 inch to 3/4 inch).
- CC. Synthetic Fibers: Monofilament or fibrillated polypropylene fibers for secondary reinforcing of concrete members. Use appropriate length and 0.9 kg/m<sup>3</sup> (1.5 lb. per cubic yard). Product shall have a UL rating.
- DD. Steel Fibers: ASTM A820, Type I cold drawn, high tensile steel wire for use as primary reinforcing in slab-on-grade. Minimum dosage rate 18 kg/m<sup>3</sup> (30 lb. per cubic yard).

- EE. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.
- FF. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.
- GG. Architectural Concrete: For areas designated as architectural concrete on the Contract Documents, use colored cements and specially selected aggregates as necessary to produce a concrete of a color and finish which exactly matches the designated sample panel.
- HH. Reinforcing Steel Mechanical Couplers: Classified as Type 2 Mechanical Couplers per ACI 318. Coupler to be capable of developing 100 percent of the specified tensile strength of the steel and, in tension and compression, at least 125 percent of the specified yield strength (Fy) of the bar. Coupler to have a current ICC-ES report classifying the coupler as Type 2 per ACI. Couplers are to be of the type that are threaded or welded to the ends of the reinforcing bars. Couplers utilizing bolts to attach the coupler to the reinforcing bar are not acceptable.
- II. Headed and Mechanically Anchored Reinforcement: Headed and mechanically anchored deformed reinforcement is to comply with the provisions of ACI 318, Section 12.6. Products are to be capable of developing the full yield strength of the bar in tension and are to have a current ICC-ES report showing compliance with ACI.
- JJ. Shrinkage Reducing Admixture: ASTM C494/C 494M, ASTM C 157

### **2.3 CONCRETE MIXES:**

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
  - 1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
  - 2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m<sup>3</sup> (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement-fly ash ratio, and consistency of each cylinder in terms of slump, include dry unit weight of lightweight structural concrete.
  - 3. Prepare a curve showing relationship between water-cement-fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
  - 4. If the field experience method is used, submit complete standard deviation analysis.
- B. Fly Ash Testing: Submit certificate verifying conformance with specifications initially with mix design and for each truck load of fly ash delivered from source. Notify Resident Engineer immediately when change in source is anticipated. Prior to beginning trial mixes submit to the Resident Engineer the following representative samples of material to be

used, properly identified source and project description and number, type of testing (complete chemical and physical), suitably packaged for shipment, and addressed as specified. Allow 60 calendar days for test results after submittal of sample.

1. Fly ash - 2.25 kg (five pounds).
  2. Portland cement - 3.5 kg (8 pounds):
    - a. Address -Waterways Experiment Station (WES)
    - b. 3909 Halls Ferry Road
    - c. Vicksburg, MS 39180-6199
    - d. ATTN: Engineering Materials Group
- C. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of Resident Engineer or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. Resident Engineer may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.
- D. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. Use Fly Ash as an admixture with 20% replacement by weight in all structural work. Increase this replacement to 40% for mass concrete, and reduce it to 10% for drilled piers and caissons.

**TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE**

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio
35 (5000) <sup>1,2</sup>	375 (630)	0.45	385 (650)	0.40
30 (4000) <sup>1,2</sup>	325 (550)	0.45	340 (570)	0.40

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
2. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.

- E. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances as established by ASTM C94, for concrete to be vibrated shall be as shown in Table II.

**TABLE II - MAXIMUM SLUMP, mm (INCHES) \***

Type of Construction	Normal Weight Concrete	Lightweight Structural Concrete
Reinforced Footings and Substructure Walls	75mm (3 inches)	75 mm (3 inches)
Slabs, Beams, Reinforced Walls, and Building Columns	100 mm (4 inches)	100 mm (4 inches)

- F. Slump may be increased by the use of the approved high-range water-reducing admixture (superplasticizer). Tolerances as established by ASTM C94. Concrete containing the high-range-water-reducing admixture may have a maximum slump of 225 mm (9 inches). The concrete shall arrive at the job site at a slump of 50 mm to 75 mm (2 inches to 3 inches), and 75 mm to 100 mm (3 inches to 4 inches) for lightweight concrete. This should be verified, and then the high-range-water-reducing admixture added to increase the slump to the approved level.
- G. Air-Entrainment: Air-entrainment of normal weight concrete shall conform with Table III. Air-entrainment of lightweight structural concrete shall conform with Table IV. Determine air content by either ASTM C173 or ASTM C231.

**TABLE III - TOTAL AIR CONTENT**

**FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

Nominal Maximum Size of Total Air Content	Coarse Aggregate, mm (Inches) Percentage by Volume
10 mm (3/8 in).6 to 10	13 mm (1/2 in).5 to 9
20 mm (3/4 in).4 to 8	25 mm (1 in).3-1/2 to 6-1/2
40 mm (1 1/2 in).3 to 6	

**TABLE IV**

**AIR CONTENT OF LIGHTWEIGHT STRUCTURAL CONCRETE**

Nominal Maximum size of Total Air Content	Coarse Aggregate, mm's (Inches) Percentage by Volume
Greater than 10 mm (3/8 in) 4 to 8	10 mm (3/8 in) or less 5 to 9

- H. Drying Shrinkage: Test per ASTM C192 and ASTM C157.
1. Typical: Maximum 0.050 percent unless otherwise indicated.

2. Slabs-on-grade and Suspended Slabs: Maximum 0.045 percent.
  3. Shrinkage Reducing Admixture: Provide as required to obtain drying shrinkage when adequate shrinkage data for concrete mix design is not available.
- 
- I. High early strength concrete, made with Type III cement or Type I cement plus non-corrosive accelerator, shall have a 7-day compressive strength equal to specified minimum 28-day compressive strength for concrete type specified made with standard Portland cement.
  - J. Lightweight structural concrete shall not weigh more than air-dry unit weight of 115 pounds per cubic foot. Air-dry unit weight determined on 150 mm by 300 mm (6 inch by 12 inch) test cylinders after seven days standard moist curing followed by 21 days drying at  $23 \text{ degrees C} \pm 1.7 \text{ degrees C}$  ( $73.4 \pm 3 \text{ degrees Fahrenheit}$ ), and 50 (plus or minus 7) percent relative humidity. Use wet unit weight of fresh concrete as basis of control in field.
  - K. Concrete slabs placed at air temperatures below 10 degrees C (50 degrees Fahrenheit) use non-corrosive, non-chloride accelerator. Concrete required to be air entrained use approved air entraining admixture. Pumped concrete, synthetic fiber concrete, architectural concrete, concrete required to be watertight, and concrete with a water/cement ratio below 0.50 use high-range water-reducing admixture (superplasticizer).
  - L. Durability: Use air entrainment for exterior exposed concrete subjected to freezing and thawing and other concrete shown or specified. Air content as shown in Table III or Table IV.
  - M. Enforcing Strength Requirements: Test as specified in Section 01 45 29, TESTING LABORATORY SERVICES, during the progress of the work. Seven-day tests may be used as indicators of 28-day strength. Average of any three 28-day consecutive strength tests of laboratory-cured specimens representing each type of concrete shall be equal to or greater than specified strength. No single test shall be more than 3.5 MPa (500 psi) below specified strength. Interpret field test results in accordance with ACI 214. Should strengths shown by test specimens fall below required values, Resident Engineer may require any one or any combination of the following corrective actions, at no additional cost to the Government:
    1. Require changes in mix proportions by selecting one of the other appropriate trial mixes or changing proportions, including cement content, of approved trial mix.
    2. Require additional curing and protection.
    3. If five consecutive tests fall below 95 percent of minimum values given in Table I or if test results are so low as to raise a question as to the safety of the structure, Resident Engineer may direct Contractor to take cores from portions of the structure. Use results from cores tested by the Contractor retained testing agency to analyze structure.
    4. If strength of core drilled specimens falls below 85 percent of minimum value given in Table I, Resident Engineer may order load tests, made by Contractor retained testing agency, on portions of building so

affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.

5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the Resident Engineer.

## **2.4 BATCHING AND MIXING:**

- A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the site is permitted. Mixing process and equipment must be approved by Resident Engineer. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38°C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1. degrees to 4.4 degrees C (30 degrees to 40 degrees F)	15.6 degrees C (60 degrees F.)
-17 degrees C to -1.1 degrees C (0 degrees to 30 degrees F.)	21 degrees C (70 degrees F.)

1. Services of aggregate manufacturer's representative shall be furnished during the design of trial mixes and as requested by the Resident Engineer for consultation during batching, mixing, and placing operations of lightweight structural concrete. Services will be required until field controls indicate that concrete of required quality is being furnished. Representative shall be thoroughly familiar with the structural lightweight aggregate, adjustment and control of mixes to produce concrete of required quality. Representative shall assist and advise Resident Engineer.

## **PART 3 - EXECUTION**

### **3.1 FORMWORK:**

- A. General: Design in accordance with ACI 347 is the responsibility of the Contractor. The Contractor shall retain a registered Professional Engineer to design the formwork, shores, and reshores.
  1. Form boards and plywood forms may be reused for contact surfaces of exposed concrete only if thoroughly cleaned, patched, and repaired and Resident Engineer approves their reuse.
  2. Provide forms for concrete footings unless Resident Engineer determines forms are not necessary.
  3. Corrugated fiberboard forms: Place forms on a smooth firm bed, set tight, with no buckled cartons to prevent horizontal displacement, and in a dry condition when concrete is placed.



- B. Treating and Wetting: Treat or wet contact forms as follows:
1. Coat plywood and board forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
  2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
  3. Use sealer on reused plywood forms as specified for new material.
- C. Size and Spacing of Studs: Size and space studs, wales and other framing members for wall forms so as not to exceed safe working stress of kind of lumber used nor to develop deflection greater than  $1/270$  of free span of member.
- D. Unlined Forms: Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges of sheets to prevent leakage. Back up all vertical joints solidly and nail edges of adjacent sheets to same stud with 6d box nails spaced not over 150 mm (6 inches) apart.
- E. Lined Forms: May be used in lieu of unlined plywood forms. Back up form lining solidly with square edge board lumber securely nailed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Nail abutted edges of sheets to same backing board. Nail lining at not over 200 mm (8 inches) on center along edges and with at least one nail to each square foot of surface area; nails to be 3d blued shingle or similar nails with thin flatheads.
- F. Architectural Liner: Attach liner as recommended by the manufacturer with tight joints to prevent leakage.
- G. Wall Form Ties: Locate wall form ties in symmetrically level horizontal rows at each line of wales and in plumb vertical tiers. Space ties to maintain true, plumb surfaces. Provide one row of ties within 150 mm (6 inches) above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 450 mm (18 inches) on center.
1. Tighten row of ties at bottom of form just before placing concrete and, if necessary, during placing of concrete to prevent seepage of concrete and to obtain a clean line. Ties to be entirely removed shall be loosened 24 hours after concrete is placed and shall be pulled from least important face when removed.
  2. Coat surfaces of all metal that is to be removed with paraffin, cup grease or a suitable compound to facilitate removal.
- H. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, forms for floor hinge boxes, inserts or bond blocks for elevator guide rails and supports, and other items specified as furnished under this and other sections of specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned, and built into construction, and maintained securely in place.

1. Locate inserts or hanger wires for furred and suspended ceilings only in bottom of concrete joists, or similar concrete member of overhead concrete joist construction.
2. Install sleeves, inserts and similar items for mechanical services in accordance with drawings prepared specially for mechanical services. Contractor is responsible for accuracy and completeness of drawings and shall coordinate requirements for mechanical services and equipment.
3. Do not install sleeves in beams, joists or columns except where shown or permitted by Resident Engineer. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the Resident Engineer, and require no structural changes, at no additional cost to the Government. All sleeves are to be positioned such that specified concrete cover on reinforcing steel is maintained.
4. Minimum clear distance of embedded items such as conduit and pipe is at least three times diameter of conduit or pipe, except at stub-ups and other similar locations.
5. Provide recesses and blockouts in floor slabs for door closers and other hardware as necessary in accordance with manufacturer's instructions.

I. Construction Tolerances:

1. Set and maintain concrete formwork to assure erection of completed work within tolerances specified and to accommodate installation of other rough and finish materials. Accomplish remedial work necessary for correcting excessive tolerances. Erected work that exceeds specified tolerance limits shall be remedied or removed and replaced, at no additional cost to the Government.
2. Permissible surface irregularities for various classes of materials are defined as "finishes" in specification sections covering individual materials. They are to be distinguished from tolerances specified which are applicable to surface irregularities of structural elements.

**3.2 PLACING REINFORCEMENT:**

- A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise shown.
- B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.
  1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Use epoxy-coated tie wire with epoxy-coated reinforcing. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 318 and ACI 315. Where concrete slabs are placed on ground, use concrete blocks or other

- non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports will not be permitted.
2. Lap welded wire fabric at least 1 1/2 mesh panels plus end extension of wires not less than 300 mm (12 inches) in structural slabs. Lap welded wire fabric at least 1/2 mesh panels plus end extension of wires not less than 150 mm (6 inches) in slabs on grade.
  3. Splice column steel at no points other than at footings and floor levels unless otherwise shown.
- C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate, unless otherwise noted on drawings.
- D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:
1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11). Minimum lengths of lap as shown.
  2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength (fy) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
    - a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
    - b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
    - c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by Resident Engineer.
  3. Mechanical Splices: Develop 100 percent of the specified tensile strength and, in tension and compression at least 125 percent of the yield strength (fy) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
    - a. Initial qualification: In the presence of Resident Engineer, make three test mechanical splices of each bar size proposed to be spliced. Department of Veterans Affairs retained testing laboratory will perform load test.
    - b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.
- E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Resident Engineer.
- F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.

- G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

### **3.3 VAPOR BARRIER:**

- A. Except where membrane waterproofing is required, interior concrete slab on grade shall be placed on a continuous vapor barrier.
  - 1. Vapor barrier joints lapped 150 mm (6 inches) and sealed with compatible waterproof pressure-sensitive tape.
  - 2. Patch punctures and tears.
  - 3. Install vapor barrier in accordance with manufacturer requirements.

### **3.4 MOISTURE VAPOR EMISSIONS & ALKALINITY CONTROL SEALER:**

- A. Sealer is applied on the day of the concrete pour or as as soon as harsh weather permits, prior to any other chemical treatments for concrete slabs either on grade, below grade or above grade receiving resilient flooring, such as, sheet vinyl, vinyl composition tile, rubber, wood flooring, carpet, epoxy coatings and overlays.
- B. Manufacturer's representative will be on the site the day of concrete pour to install or train its application and document. He shall return on every application thereafter to verify that proper procedures are followed.
  - 1. Apply Sealer to concrete slabs as soon as final finishing operations are complete and the concrete has hardened sufficiently to sustain floor traffic without damage.
  - 2. Spray-apply Sealer at the rate of 20 m<sup>2</sup> (200 square feet) per gallon. Lightly broom product evenly over the substrate and product has completely penetrated the surface.
  - 3. If within two (2) hours after initial application areas are subjected to heavy rainfall and puddling occurs, reapply Sealer product to these areas as soon as weather condition permits.

### **3.5 CONSTRUCTION JOINTS:**

- A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 24,000 mm (80 feet) in any horizontal direction, except slabs on grade which shall have construction joints shown. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by Resident Engineer.
- B. Locate construction joints in suspended floors near the quarter-point of spans for slabs, beams or girders, unless a beam intersects a girder at center, in which case joint in girder shall be offset a distance equal to twice width of beam. Provide keys and inclined dowels as shown. Provide longitudinal keys as shown.
- C. Place concrete for columns slowly and in one operation between joints. Install joints in concrete columns at underside of deepest beam or girder framing into column.

- D. Allow 2 hours to elapse after column is cast before concrete of supported beam, girder or slab is placed. Place girders, beams, grade beams, column capitals, brackets, and haunches at the same time as slab unless otherwise shown.
- E. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

### **3.6 EXPANSION JOINTS:**

- A. Clean expansion joint surfaces before installing premolded filler and placing adjacent concrete.
- B. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

### **3.7 PLACING CONCRETE:**

- A. Preparation:
  - 1. Remove hardened concrete, wood chips, shavings and other debris from forms.
  - 2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
  - 3. Have forms and reinforcement inspected and approved by Resident Engineer before depositing concrete.
  - 4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.
- B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles. Roughen surfaces to 1/4 inch minimum amplitude by heavy sand-blasting, waterblasting or bush-hammering.
  - 1. Preparing surface for applied topping:
    - a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
    - b. Broom clean and keep base slab wet for at least four hours before topping is applied.
    - c. Use a thin coat of one part Portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.
- C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete subject to approval of Resident Engineer.

- D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.
1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
  2. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
  3. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (superplasticizer) or 1500 mm (5 feet) for conventional concrete. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.
  4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
  5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after it's initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
  6. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (superplasticizer). Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.
  7. Concrete on metal deck:
    - a. Concrete on metal deck shall be minimum thickness shown. Allow for deflection of steel beams and metal deck under the weight of wet concrete in calculating concrete quantities for slab.
      - 1) The Contractor shall become familiar with deflection characteristics of structural frame to include proper amount of additional concrete due to beam/deck deflection.
- E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000 cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.
1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
  2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

**3.8 HOT WEATHER:**

- A. Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.

**3.9 COLD WEATHER:**

- A. Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.

**3.10 PROTECTION AND CURING:**

- A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Resident Engineer.
  - 1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 10m<sup>2</sup>/L (400 square feet per gallon) on steel troweled surfaces and 7.5m<sup>2</sup>/L (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
  - 2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.
  - 3. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

**3.11 REMOVAL OF FORMS:**

- A. Remove in a manner to assure complete safety of structure after the following conditions have been met.
  - 1. Where structure as a whole is supported on shores, forms for beams and girder sides, columns, and similar vertical structural members may be removed after 24 hours, provided concrete has hardened

sufficiently to prevent surface damage and curing is continued without any lapse in time as specified for exposed surfaces.

2. Take particular care in removing forms of architectural exposed concrete to insure surfaces are not marred or gouged, and that corners and arises are true, sharp and unbroken.
- B. Control Test: Use to determine if the concrete has attained sufficient strength and curing to permit removal of supporting forms. Cylinders required for control tests taken in accordance with ASTM C172, molded in accordance with ASTM C31, and tested in accordance with ASTM C39. Control cylinders cured and protected in the same manner as the structure they represent. Supporting forms or shoring not removed until strength of control test cylinders have attained at least 70 percent of minimum 28-day compressive strength specified. For post-tensioned systems supporting forms and shoring not removed until stressing is completed. Exercise care to assure that newly unsupported portions of structure are not subjected to heavy construction or material loading.
- C. Reshoring: Reshoring is required if superimposed load plus dead load of the floor exceeds the capacity of the floor at the time of loading. Reshoring accomplished in accordance with ACI 347 at no additional cost to the Government.

### **3.12 CONCRETE SURFACE PREPARATION:**

- A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.
- B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 25 mm (1 inch). Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 150 mm (6 inches) surrounding before placing patching mortar. Give area to be patched a brush coat of cement grout followed immediately by patching mortar. Cement grout composed of one part Portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio, mix to achieve consistency of thick paint. Mix patching mortar approximately 1 hour before placing and remix occasionally during this period without addition of water. Compact mortar into place and screed slightly higher than surrounding surface. After initial shrinkage has occurred, finish to match color and texture of adjoining surfaces. Cure patches as specified for other concrete. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.
- C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose



aggregates to provide a clean, firm, granular surface for bond of applied finish.

### **3.13 CONCRETE FINISHES:**

#### **A. Vertical and Overhead Surface Finishes:**

1. Unfinished areas: Vertical and overhead concrete surfaces exposed in pipe basements, elevator and dumbwaiter shafts, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by Resident Engineer, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.
3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:
  - a. After concrete has hardened and laitance, fins and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
  - b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600  $\mu\text{m}$  (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
  - c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.
  - d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.
4. Textured: Finish as specified. Maximum quantity of patched area 0.2  $\text{m}^2$  (2 square feet) in each 93  $\text{m}^2$  (1000 square feet) of textured surface.

#### **B. Slab Finishes:**

1. Monitoring and Adjustment: Provide continuous cycle of placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances. Monitor elevations of structural steel in key locations before and after concrete placement to establish typical deflection patterns for the structural steel. Determine elevations of cast-in-place slab soffits prior to removal of shores. Provide information to Resident Engineer and floor consultant for evaluation and recommendations for subsequent placements.
2. Set perimeter forms to serve as screed using either optical or laser instruments. For slabs on grade, wet screeds may be used to establish initial grade during strike-off, unless Resident Engineer determines that the method is proving insufficient to meet required finish tolerances and directs use of rigid screed guides. Where wet screeds are allowed, they shall be placed using grade stakes set by optical or laser instruments. Use rigid screed guides, as opposed to wet

- screeds, to control strike-off elevation for all types of elevated (non slab-on-grade) slabs. Divide bays into halves or thirds by hard screeds. Adjust as necessary where monitoring of previous placements indicates unshored structural steel deflections to other than a level profile.
3. Place slabs monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, whether shown or not.
  4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimensioned lumber. Strike off and screed slab to a true surface at required elevations. Use optical or laser instruments to check concrete finished surface grade after strike-off. Repeat strike-off as necessary. Complete screeding before any excess moisture or bleeding water is present on surface. Do not sprinkle dry cement on the surface.
  5. Immediately following screeding, and before any bleed water appears, use a 3000 mm (10 foot) wide highway straightedge in a cutting and filling operation to achieve surface flatness. Do not use bull floats or darbys, except that darbying may be allowed for narrow slabs and restricted spaces.
  6. Wait until water sheen disappears and surface stiffens before proceeding further. Do not perform subsequent operations until concrete will sustain foot pressure with maximum of 6 mm (1/4 inch) indentation.
  7. Refer to Section 09 06 00 SCHEDULE OF FINISHES for surface finish requirements.
  8. Scratch Finish: Finish base slab to receive a bonded applied cementitious application as indicated above, except that bull floats and darbys may be used. Thoroughly coarse wire broom within two hours after placing to roughen slab surface to insure a permanent bond between base slab and applied materials.
  9. Float Finish: Slabs to receive unbonded toppings, steel trowel finish, fill, mortar setting beds, or a built-up roof, and ramps, stair treads, platforms (interior and exterior), and equipment pads shall be floated to a smooth, dense uniform, sandy textured finish. During floating, while surface is still soft, check surface for flatness using a 3000 mm (10 foot) highway straightedge. Correct high spots by cutting down and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections and re-float to a uniform texture.
  10. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work, future floor roof slabs, applied toppings, and other interior surfaces for which no other finish is indicated. Steel trowel immediately following floating. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure to compact cement paste and form a dense, smooth surface. Finished surface shall be smooth, free of trowel marks, and uniform in texture and appearance.

11. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by Resident Engineer from sample panel.
12. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:
  - a. Areas covered with carpeting, or not specified otherwise in b. below:
    - 1) Slab on Grade:
      - a) Specified overall value FF 25/FL 20
      - b) Minimum local value FF 17/FL 15
    - 2) Level suspended slabs (shored until after testing) and topping slabs:
      - a) Specified overall value FF 25/FL 20
      - b) Minimum local value FF 17/FL 15
    - 3) Unshored suspended slabs:
      - a) Specified overall value FF 25
      - b) Minimum local value FF 17
    - 4) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.
  - b. Areas that will be exposed, receive thin-set tile or resilient flooring, or roof areas designed as future floors:
    - 1) Slab on grade:
      - a) Specified overall value FF 36/FL 20
      - b) Minimum local value FF 24/FL 15
    - 2) Level suspended slabs (shored until after testing) and topping slabs
      - a) Specified overall value FF 30/FL 20
      - b) Minimum local value FF 24/FL 15
    - 3) Unshored suspended slabs:
      - a) Specified overall value FF 30
      - b) Minimum local value FF 24
    - 4) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.
  - c. "Specified overall value" is based on the composite of all measured values in a placement derived in accordance with ASTM E1155.
  - d. "Minimum local value" (MLV) describes the flatness or levelness below which repair or replacement is required. MLV is based on the results of an individual placement and applies to a minimum local area. Minimum local area boundaries may not cross a construction joint or expansion joint. A minimum local area will be bounded by construction and/or control joints, or by column lines and/or half-column lines, whichever is smaller.

13. Measurements

- a. Department of Veterans Affairs retained testing laboratory will take measurements as directed by Resident Engineer, to verify compliance with FF, FL, and other finish requirements. Measurements will occur within 72 hours after completion of concrete placement (weekends and holidays excluded). Make measurements before shores or forms are removed to insure the "as-built" levelness is accurately assessed. Profile data for above characteristics may be collected using a laser level or any Type II apparatus (ASTM E1155, "profileograph" or "dipstick"). Contractor's surveyor shall establish reference elevations to be used by Department of Veterans Affairs retained testing laboratory.
- b. Contractor not experienced in using FF and FL criteria is encouraged to retain the services of a floor consultant to assist with recommendations concerning adjustments to slab thicknesses, finishing techniques, and procedures on measurements of the finish as it progresses in order to achieve the specific flatness and levelness numbers.

14. Acceptance/ Rejection:

- a. If individual slab section measures less than either of specified minimum local FF/FL numbers, that section shall be rejected and remedial measures shall be required. Sectional boundaries may be set at construction and contraction (control) joints, and not smaller than one-half bay.
- b. If composite value of entire slab installation, combination of all local results, measures less than either of specified overall FF/FL numbers, then whole slab shall be rejected and remedial measures shall be required.

15. Remedial Measures for Rejected Slabs: Correct rejected slab areas by grinding, planing, surface repair with underlayment compound or repair topping, retopping, or removal and replacement of entire rejected slab areas, as directed by Resident Engineer, until a slab finish constructed within specified tolerances is accepted.

**3.14 SURFACE TREATMENTS:**

- A. Use on exposed concrete floors and concrete floors to receive carpeting except those specified to receive non-slip finish.
- B. Liquid Densifier/Sealer: Apply in accordance with manufacturer's directions just prior to completion of construction.
- C. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Broadcast aggregate uniformly over concrete surface at rate of application of 8% per 1/10th m<sup>2</sup> (7.5 percent per square foot) of area. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water to slightly expose abrasive aggregate.

**3.15 APPLIED TOPPING:**

- A. Separate concrete topping on floor base slab of thickness and strength shown. Topping mix shall have a maximum slump of 200 mm (8 inches) for concrete containing a high-range water-reducing admixture (superplasticizer) and 100 mm (4 inches) for conventional mix. Neatly bevel or slope at door openings and at slabs adjoining spaces not receiving an applied finish.
- B. Placing: Place continuously until entire section is complete, struck off with straightedge, leveled with a highway straightedge or highway bull float, floated and troweled by machine to a hard dense finish. Slope to floor drains as required. Do not start floating until free water has disappeared and no water sheen is visible. Allow drying of surface moisture naturally. Do not hasten by "dusting" with cement or sand.

**3.16 RETAINING WALLS:**

- A. Use air-entrained concrete.
- B. Expansion and contraction joints, waterstops, weep holes, reinforcement and railing sleeves installed and constructed as shown.
- C. Exposed surfaces finished to match adjacent concrete surfaces, new or existing.
- D. Place porous backfill as shown.

**3.17 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 03 41 00**

**PRECAST STRUCTURAL CONCRETE FOR STEAM TRENCHES AND VAULTS**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Below grade steam trench sections.
- B. Grout packing.
- C. Connection and supporting devices.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

**1.3 REFERENCE STANDARDS**

- A. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.
- B. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2005.
- C. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- D. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete; 2007.
- E. ASTM A 497/A 497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete; 2007.
- F. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2007.
- G. ASTM C 150 - Standard Specification for Portland Cement; 2007.
- H. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006 and Errata.
- I. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; American Welding Society; 2005.

- J. PCI MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products; Precast/Prestressed Concrete Institute; 1999, Fourth Edition.
- K. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete; Precast/Prestressed Concrete Institute; 1988, Second Edition.
- L. PCI MNL-135 - Tolerance Manual for Precast and Prestressed Concrete Construction; Precast/Prestressed Concrete Institute; 2000.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Convene a pre-installation conference one week prior to commencing work of this section.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Product Data: Indicate standard component configurations, design loads, deflections, cambers, and bearing requirements.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Shop Drawings: Indicate layout, unit locations, fabrication details, unit identification marks, reinforcement, connection details, support items, dimensions, openings, and relationship to adjacent materials. Indicate design loads, deflections, cambers, bearing requirements, and special conditions. Drawings to be stamped and signed by a Professional Engineer registered in the State of California
- E. Design Data: Submit design data reports indicating calculations for loadings and stresses of fabricated, designed framing. Calculations to be stamped and signed by a Professional Engineer registered in the State of California. See drawings and the Geotechnical Report for design loading criteria.
- F. LEED Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace portland cement, submit the total volume of concrete, mix design(s) used showing the quantity of portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used; use LEED New Product Content Form.



## **1.6 QUALITY ASSURANCE**

- A. Designer Qualifications: Design precast concrete members under direct supervision of a Professional Structural Engineer experienced in design of precast concrete and licensed in the State of California.
- B. Fabricator Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- C. Welder Qualifications: Qualified within previous 12 months in accordance with AWS D1.1 and AWS D1.4.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Handle precast members in position consistent with their shape and design. Lift and support only from support points.
- B. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
- C. Mark each member with date of production and final position in structure.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Structural Precast Concrete:
  - 1. Any manufacturer holding a PCI Group C Plant Certification for the types of products specified; see [www.pci.org/find/manufacturer](http://www.pci.org/find/manufacturer).

### **2.2 PRECAST UNITS**

- A. Precast Structural Concrete Units: Comply with PCI MNL-116, PCI MNL-120, PCI MNL-123, PCI MNL-135, ACI 318 and applicable codes.
  - 1. Design components to withstand dead loads and design loads in the configuration indicated on the drawings.
  - 2. Calculate structural properties of framing members in accordance with ACI 318.
  - 3. Replace as much portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with strength requirements.
  - 4. Design members exposed to the weather to provide for movement of components without damage, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to seasonal or cyclic day/night temperature ranges.
  - 5. Design system to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.

### **2.3 MATERIALS**

- A. Cement: White portland type, conforming to ASTM C 150, Type I.
- B. Aggregate, Sand, Water, Admixtures: Determined by precast fabricator as appropriate to design requirements and PCI MNL-116.

### **2.4 REINFORCEMENT**

- A. Reinforcing Steel, #7 bars and smaller: ASTM A615, deformed, grade 60.
- B. Reinforcing Steel, #8 and larger and all bars to be welded: ASTM A706, grade 60. Permitted for bars #7 and smaller.
- C. Steel Welded Wire Reinforcement: ASTM A 185/A 185M plain type or ASTM A 497/A 497M deformed type; in flat sheets; unfinished.

### **2.5 ACCESSORIES**

- A. Connecting and Supporting Devices: Plates, angles, items cast into concrete, and inserts conforming to PCI MNL-123, and as follows:
  - 1. Material: Carbon steel conforming to ASTM A 36/A 36M.
  - 2. Finish: Hot-dip galvanized in accordance with ASTM A 153/A 153M.
- B. Grout:
  - 1. Non-shrink, non-metallic, minimum yield strength of 10,000 psi (69 MPa) at 28 days.
  - 2. Epoxy.
- C. Bearing Pads: High density plastic, Vulcanized elastomeric compound molded to size, Neoprene (Chloroprene), or Tetrafluoroethylene (TFE); 1/8 inch (3 mm) thick, smooth both sides.
- D. Bolts, Nuts and Washers: High strength steel type recommended for structural steel joints.
- E. Prime Paint: Zinc rich alkyd type.

### **2.6 LATEX-RUBBER WATERPROOFING**

- A. Two-Component, Unreinforced, Latex-Rubber Waterproofing: ASTM C 836/C 836M; coal-tar free.
  - 1. Hydrostatic-Head Resistance: 65 feet (20 m) minimum; ASTM D 5385.
- B. Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing that complies with VOC limits of Bay Area Air Quality Management District (BAAQMD).
- C. Sheet Strips: Self-adhering, reinforced, rubberized-asphalt strips, minimum 60-mil (1.5-mm) nominal thickness, consisting of 56 mils (1.4 mm)

of rubberized asphalt laminated on one side to a 4-mil (0.10-mm) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of Bay Area Air Quality Management District (BAAQMD).

1. Primer: Liquid solvent-borne primer recommended for substrate by sheet-waterproofing material manufacturer.

## **2.7 FABRICATION**

- A. Conform to fabrication procedures specified in PCI MNL-116.
- B. Maintain plant records and quality control program during production of precast members. Make records available upon request.
- C. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on shop drawings.
- D. Provide required openings with a dimension larger than 10 inches (250 mm) and embed accessories provided under other sections of the specifications, at indicated locations.

## **2.8 FINISHES**

- A. Ensure exposed-to-view finish surfaces of precast concrete members are uniform in color and appearance.
- B. Cure members under identical conditions to develop required concrete quality, and minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- C. Finish members to PCI MNL-116 Commercial grade.
- D. Plant Finish: Normal plant finish; surface may contain small surface holes caused by air bubbles, minor chips or spalling at edges or ends, without major discoloration.

## **2.9 FABRICATION TOLERANCES**

- A. Conform to fabrication tolerances specified in PCI MNL-135, except as specifically amended below.
  1. Variation From Nominal Dimension: Plus or minus 1/2 inch (12.5 mm).
  2. Variation From Intended Camber: Plus or minus 1/4 in per 10 ft (6 mm per 3 m), plus or minus 5/8 inch (15 mm) maximum.
  3. Variation from End Squareness: Plus or minus 1/8 inch/12 in (3 mm/300 mm), maximum 3/8 in (9 mm).
  4. Maximum Misalignment of Anchors, Inserts, Openings: Plus or minus 1/8 inch (3 mm).

## **2.10 SOURCE QUALITY CONTROL**

- A. Section 01 45 29 - TESTING LABORATORY SERVICES: Provide mix design for concrete.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that site conditions are ready to receive work and field measurements are as shown on shop drawings.

### **3.2 PREPARATION**

- A. Prepare support equipment for the erection procedure, temporary bracing, and induced loads during erection.
- B. Prepare subgrade in accordance with the drawings, specifications and geotechnical report requirements.

### **3.3 ERECTION**

- A. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Align and maintain uniform horizontal and vertical joints, as erection progresses.
- C. Maintain temporary bracing in place until final support is provided. Protect members from staining.
- D. Provide temporary lateral support to prevent bowing, twisting, or warping of members.
- E. Grout underside of column bearing plates.
- F. Secure units in place. Perform welding in accordance with AWS D1.1.

### **3.4 TOLERANCES**

- A. Erect members level and plumb within allowable tolerances.
- B. Conform to PCI MNL-135 for erection tolerances.

### **3.5 WATERPROOFING APPLICATION**

- A. Clean, prepare, and treat substrates. Provide clean, dust-free, and dry substrates for waterproofing application.
- A. Prepare surfaces at terminations and penetrations through waterproofing and at joints and corners. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions.

- B. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C 1471.

### **3.6 PROTECTION**

- A. Protect members from damage caused by field welding or erection operations.

### **3.7 CLEANING**

- A. Clean weld marks, dirt, or blemishes from surface of exposed members.

### **3.8 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 03 47 13**

**TILT-UP CONCRETE**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Tilt-up, site cast concrete wall panels, erected from forms to final position.
- B. Supports, devices, and attachments.
- C. Grouting under panels.
- D. Waterproofing.

**1.2 RELATED REQUIREMENTS**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 03 30 00 - CAST-IN-PLACE CONCRETE: Requirements for concrete for tilt-up panels, reinforcing steel and welding requirements.
- D. Section 05 50 00 - METAL FABRICATIONS: Miscellaneous metal for embedment.
- E. Section 07 92 00 - JOINT SEALANTS: Calking of perimeter joint with sealant and backing.
- F. Section 09 91 00 - PAINTING: Field applied painting of tilt-up panels.

**1.3 REFERENCE STANDARDS**

- A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.
- B. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- C. ACI 305R - Hot Weather Concreting; 1999.
- D. ACI 306R - Cold Weather Concreting; 1988 (Reapproved 2002).
- E. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2008.
- F. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2005.

- G. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.
- H. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.
- I. ASTM C 78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading); 2008.
- J. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2007.
- K. ASTM C 143/C 143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2005a.
- L. ASTM C 171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.
- M. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2007.
- N. ASTM C 1107/C 1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2007a.
- O. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006 and Errata.
- P. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; American Welding Society; 2005

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Convene not later than one week prior to commencing work of this section.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Provide submittals per Section 03 30 00 CAST-IN-PLACE CONCRETE UNLESS OTHERWISE NOTED.
- C. Product Data: Submit manufacturers' current data on manufactured items used, including recommended methods of installation, relevant installation limitations, and safety precautions.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by



vendor, installer, subcontractor, and/or manufacturer as appropriate.

- E. Shop Drawings: Complying with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE. Indicate layout, tilt-up unit locations, configuration, unit identification marks, reinforcement, connection details, support items, location of lifting devices, dimensions, openings, and relationship to adjacent components.
- F. Lifting Device and Bracing Calculations: Structural calculations for the design of lifting devices and bracing for construction loads, stamped and signed by a Professional Engineer licensed in the State of California.
- G. Proposed Mix Design: Complying with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

#### **1.6 QUALITY ASSURANCE**

- A. Perform work in accordance with ACI 318.
- B. Maintain one copy of quality assurance standards on project site.
- C. Fabricator Qualifications: Company specializing in site-cast tilt-up concrete construction with minimum 5 years of documented experience.
- D. Welding Qualifications: Welding processes and welding operators qualified within previous 12 months in accordance with AWS D1.1 and AWS D1.4.

#### **1.7 MOCK-UP**

- A. Provide mock-up panel as quality control for architectural finishes, coordination of work with other sections, testing, and observation of operation.
  - 1. Panel Size: Minimum 4 by 8 feet (1200 by 2400 mm), using forming system and construction methods to be used on project.
  - 2. Details: Incorporate typical edge and reveal conditions as detailed.
- B. Locate where directed and maintain approved mock-up for comparison to finished work.
- C. Mock-up may not remain as part of the Work.
  - 1. Dispose of mock-up when directed by Architect.

#### **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Handling Tilt-up Units: Lift units to position, consistent with their shape and design. Lift and support only from support points.
- B. Blocking and Lateral Support During Erection: Use materials that are clean and non-staining. Provide temporary lateral support to prevent bowing, warping, or cracking.

- C. Protect units from staining, chipping, or spalling.

## **1.9 FIELD CONDITIONS**

- A. Adverse Weather: Do not construct formwork, place reinforcing steel or concrete, or erect panels during adverse weather unless measures acceptable to Architect are taken to prevent damage.
- B. Cold Weather: Comply with provisions of ACI 306R for freezing or near-freezing conditions.
  - 1. Provide adequate equipment for heating and protecting concrete materials.
  - 2. Do not use concrete materials, reinforcing steel, forms, fillers, ground surface, or other materials that are frozen, frost-covered or that contain ice.
- C. Hot Weather: Comply with provisions of ACI 305R for high temperature conditions.
  - 1. During periods of dry winds, low humidity, and other conditions that cause rapid drying, protect fresh concrete with an evaporation retardant or fine fog spray of water applied immediately after screeding and bull floating.
  - 2. Maintain protection until final finishing and curing compounds are applied.

## **PART 2 - PRODUCTS**

### **2.1 TILT-UP PANEL UNITS**

- A. Tilt-Up Panel Units:
  - 1. Concrete: Strength as noted on the drawings and per Section 03 30 00 CAST-IN-PLACE CONCRETE. Comply with ACI 301.
  - 2. Design Loads: Static loads, anticipated dynamic loading, including positive and negative wind loads, thermal movement loads, and erection forces as defined by applicable code.
  - 3. Calculate structural properties of units in accordance with ACI 318.
  - 4. Accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
  - 5. Provide connections that accommodate building movement and thermal movement and adjust to misalignment of structure without unit distortion or damage.
  - 6. Provide lifting hardware and lifting system appropriate to panel size and configuration.

## **2.2 PANEL MATERIALS**

- A. Forms: Design to withstand stresses resulting from concrete casting process and to maintain panels within 1/4 inch (6 mm) deflection limit; construct from steel or wood, rigidly braced and with precise corners.
  - 1. Include blockouts as required to provide openings detailed on drawings, designed to limit deflection during pouring to maximum of 1/8 inch (3 mm).
  - 2. Provide smooth and clean forming surfaces.
  - 3. Panels may be stacked for ease of casting.
  - 4. For forms attachment to slab, use non-intrusive glues or adhesives whenever possible, in lieu of nails and bolts.
- B. Concrete: Provide concrete materials in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Reinforcing Steel: As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Form Bond Breaker: Integral with or compatible with curing compound and other finishes, including paint and floor finish.
- E. Curing Compound: Liquid membrane-forming compound complying with ASTM C 309, Type I and ID, Class B.
- F. Curing Covers: Reusable, impregnated fiber mat with a white or light colored backing, complying with ASTM C 171 for reflectivity and moisture retention.
- G. Non-Shrink Grout: ASTM C 1107/C 1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  - 1. Minimum Compressive Strength at 28 Days: 10,000 psi.
- H. Reveals: For reveals or relief in panel face, provide materials of adequate strength to withstand construction traffic and loads without damage.

## **2.3 SUPPORT AND LIFTING DEVICES**

- A. Lifting Hardware, Connecting, and Support Devices: ASTM A 36/A 36M steel; hot-dip galvanized in accordance with ASTM A 153/A 153M.
- B. Miscellaneous Metal Items: Provide inserts, dowels, and other items to be cast into panels as specified in Section 05 50 00, galvanized after fabrication in accordance with ASTM A 123/A 123M.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that building structure, anchors, devices, and openings are ready to receive work of this section.
- B. Verify that casting slab specified in Section 03 30 00 - CAST-IN-PLACE CONCRETE is cured and ready for work of this section. Fill cracks, saw cuts, joints, or defects that would adversely affect appearance of tilt-up panels.

#### **3.2 PREPARATION**

- A. Coordinate site cast tilt-up operations with work of other sections to expedite the Work and avoid omissions and delays.
- B. Apply bondbreaker to casting slab in accordance with manufacturer's recommendations.
- C. Provide for erection procedures and induced loads during erection, and provide for temporary bracing that will remain in place until roof diaphragm has been completely installed and connected.

#### **3.3 FORMING PANELS**

- A. General: Maintain environmental records and quality control program during production of tilt-up units. Make records available upon request.
- B. Lay out panels in manner that will minimize joints in panel faces. Coordinate installation of inserts and anchorages.
- C. Maintain consistent quality during construction of forms.
- D. Fabricate connecting devices, plates, angles, items fit to steel framing members, inserts, bolts, and accessories. Fabricate to permit initial placement and final attachment.
- E. Embed reinforcing steel, anchors, inserts plates, angles, and other cast-in items as indicated.
- F. Locate hoisting devices to permit removal after erection.
- G. Work concrete thoroughly around reinforcement, around embedded items, and into corners of the forms. Consolidate concrete in accordance with ACI recommendations.
- H. Cold joints are not permitted in any individual panel.

#### **3.4 PLACING AND CURING CONCRETE**

- A. Mix and deliver concrete in accordance with ASTM C 94/C 94M, Option A, and in compliance with recommendations of ACI 304R.

- B. Protect freshly placed concrete from premature drying and excessively hot or cold temperatures.
- C. Cure units to develop concrete quality, and to minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- D. Apply liquid membrane curing compound in accordance with manufacturer's recommendations.
- E. Moist Curing:
  - 1. Cover panels completely with burlap strips immediately after finishing. Quickly and completely wet entire exposed surface.
  - 2. Cover panels with curing covers to prevent evaporation, and keep covered for seven days. Do not allow alternate wetting and drying.

### **3.5 FINISHING CONCRETE**

- A. Finish exposed surfaces of panels as indicated on drawings.
- B. Refer to Section 09 06 00 SCHEDULE OF FINISHES, for surface finish requirements.
- C. Interior Finish: Floated.
- D. Painting: Prepare surfaces to be painted as specified in Section 09 90 00, PAINTING.

### **3.6 SITE FABRICATION TOLERANCES**

- A. Unless otherwise approved by Architect, provide panels conforming to casting tolerances as specified below.
- B. Panel Height and Width:
  - 1. Up to 20 feet (6 m): 1/4 inch (6 mm) maximum.
  - 2. 20 to 30 feet (6 to 9 m): 3/8 inch (9.5 mm) maximum.
  - 3. Each additional 10 ft (3 m) increment: 1/8 inch (3 mm) maximum.
- C. Panel Thickness: 3/16 inch (4.8 mm) maximum average variation through any vertical or horizontal cross section.
- D. Skew of Panel or Opening: Measured as difference in length of the two diagonals:
  - 1. Per 6 feet (2 m) of diagonal dimension: 1/8 inch (3 mm) maximum.
  - 2. Maximum total difference: 1/2 inch (12.5 mm).
- E. Panel Openings:
  - 1. Size: 1/4 inch (6.4 mm) maximum.
  - 2. Location of Centerline: 1/4 inch (6.4 mm) maximum.

F. Location and Placement of Embedded Items:

1. Inserts, Bolts, and Pipe Sleeves: 3/8 inch (9.5 mm).
2. Lifting and Bracing Inserts: As specified by manufacturer.
3. Weld Plate Embedments: 1 inch (25 mm) for location; 1/4 inch (6 mm) for tipping and flushness.

**3.7 DEFECTIVE CONCRETE**

- A. Defective Concrete: If test results indicate concrete not conforming to specified requirements, Contractor with the agreement of Architect must adjust mix to provide acceptable concrete on subsequent work. For concrete not meeting specified requirements, Owner may require core specimens to be taken and tested, at Contractor's expense. Concrete cores that test below specified requirements will be deemed to be defective.
- B. Repair or replacement of defective concrete will be determined by the Architect and will be paid for by Contractor. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- C. Do not patch, fill, touch-up, repair, or replace damaged or defective concrete except upon express direction of Architect for each individual area.

**3.8 ERECTION**

- A. Before beginning erection operations, verify that site conditions are appropriate for the work. Mark elements to conform to designations indicated on approved shop drawings.
- B. Employ erection equipment that will prevent damage to existing construction, permanent floor slabs, and tilt-up panels. Protect panels to prevent staining, warping, or cracking.
- C. Set panels in assigned positions. Erect members level and plumb within allowable tolerances. Grout space under panels for full bearing, or provide additional support until subsequent grouting operations are completed.
- D. Align and maintain uniform horizontal and vertical joints, as erection progresses.
- E. When members require adjustment beyond design or tolerance criteria, discontinue affected work; advise Architect.
- F. Brace panels not attached to building frame at time of erection, using a bracing system designed to resist wind and other applicable loads until all structural connections have been made. Provide minimum of two braces per panel and maintain connections daily.
- G. Patch holes, cut-off anchors, surface defects, and damaged corners to match panel with epoxy/cement paste adhesive.
- H. Seal perimeter and intermediate joints in accordance with Section 07 92 00, JOINT SEALANTS.

- I. After panel erection, patch holes or other blemishes in casting slab that were caused by the panel casting or erection processes, using techniques acceptable to Architect.

### **3.9 ERECTION TOLERANCES**

- A. Unless otherwise approved by Architect, install site-cast tilt-up panels within erection tolerances as specified below.
- B. Replace panels that cannot be installed within specified tolerances.
- C. Joint Width Variation:
  - 1. Up to 20 feet (6 m) tall panels: 1/4 inch (6 mm) maximum.
  - 2. Each additional 10 ft (3 m) increment: 1/8 inch (3 mm) maximum.
  - 3. Do not increase or decrease joint width more than 50 percent from specified joint width in any case, as measured between panels at exterior face.
- D. Joint Taper:
  - 1. Up to 20 feet (6 m) tall panels: 1/4 inch (6 mm) maximum.
  - 2. Each additional 10 ft (3 m) increment: 1/8 inch (3 mm) maximum.
  - 3. Maximum for entire length of panel: 3/8 inch (9.5 mm) width difference for non-parallel panel edges.
- E. Panel Alignment:
  - 1. Horizontal and Vertical Joints: 1/4 inch (6 mm) maximum.
  - 2. Offset in Adjacent Exterior Panel Faces: 1/4 inch (6 mm).

### **3.10 PROTECTION**

- A. Protect units from damage by subsequent construction activities.

### **3.11 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 04 72 10**

**STONE VENEER WALL**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies stone veneer wall and curb using natural stone.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 03 30 00, CAST-IN-PLACE CONCRETE
- D. Stone specified: Section 09 06 00, SCHEDULE FOR FINISHES.
- E. Concrete Reinforcing Steel Institute (CRSI): "Manual of Standard Practice" and "Recommended Practice for Placing Reinforcing Bars".
- F. California Code of Regulations, Title 24, 2007 Edition, also known as California Building Code (CBC).

**1.3 QUALITY ASSURANCE**

- A. Pre-installation Conference: Conduct conference at Project site with Resident Engineer.
- B. Stone samples for comparison of quality and color are available from the Landscape Architect or Contracting Officer. Contractor shall request access to these samples for review, prior to submitting samples for approval.
- C. Preconstruction Soil Testing: Engage a qualified independent testing agency to test soil reinforcement and backfill materials for compliance with design criteria.
- D. Installer Qualifications: Firm specializing in design and installation of segmental retaining walls and :
1. With not less than 2 years documented experience.
  2. With a minimum of five previously constructed successful projects, similar in size and magnitude, using specified wall system; Provide contact names and numbers.
  3. Site supervisor with verifiable qualified experience suitable for this project.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
  - 1. Stone samples, size 3 by 6 by 12 inches, each color and finish.
- C. Shop Drawings:
  - 1. Cast stone showing exposed faces, profiles, cross sections, anchorage, reinforcing, jointing and sizes.
- D. List of jobs furnished by the manufacturer, which were similar in scope and at least three (3) years of age.
- E. Mockups: Build 8' long sample wall and curb mockup (each) including veneer over prepared, tested and approved concrete wall core to verify selections made under sample submittals and to demonstrate functional and aesthetic effects and set quality standards for materials and execution. Mockup should include color range, texture, bond pattern, and joints. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion. Do not continue masonry work until mock-up has been approved by Resident Engineer.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Store cement, sand, Lime and stone under waterproof covers on planking clear of ground.
- B. Protect Stone from handling, dirt, stain, and water damage.

#### **1.6 WARRANTY**

- A. Warranty exterior masonry walls against moisture leaks, any defects and subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be two years.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by the basic designation

only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

- B. Cast Stone Institute Technical Manual and Cast Stone Institute standard specifications.
- C. American Society for Testing and Materials (ASTM):
  - 1. A167-99 (2004) Stainless and Heat Resisting Chromium- Nickel Steel Plate, Sheet, and Strip
  - 2. A185-07 Steel, Welded Wire Fabric, Plain for Concrete
  - 3. A615/A615M-08 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 4. C33-07 Concrete Aggregates
  - 5. C150-07 Portland Cement
  - 6. C503-08 Marble Dimension Stone (Exterior)
  - 7. C568-08 Limestone Dimension Stone
  - 8. C615-03 Granite Dimension Stone
  - 9. C616-08 Quartz-Based Dimension Stone
  - 10. C979-05 Pigments for Integrally Colored Concrete

## **PART 2 - PRODUCTS**

### **2.1 PORTLAND CEMENT**

- A. ASTM C150, Type I.

### **2.2 SAND**

- A. ASTM C144; Natural sand containing not more than 2% of silt and clay by weight with specific gravity not less than 2.65.

### **2.3 LIME**

- A. ASTM C5, Slake; screen through 16 mesh, then store and protect for 10 days.

### **2.4 RETAINING WALL SOLID STONE UNITS**

- A. Natural stone quarried and sawn (except for face) into rectangular shapes and sizes suitable for the retaining wall configuration as shown.
  - 1. Stone Type: Rhyolite
  - 2. Color: Natural Brown tone to grays and rust colors.
  - 3. Stone native location: Napa, California
  - 4. Texture: Split face, on long surfaces and snapped on short ends. Top stone finished on top face and sides.
  - 5. Face Shape: rectangular.

6. Individual Stone Height: 4 As shown on Drawings.
  7. Individual Stone Length (face Width) As shown on Drawings.
  8. Width (Depth from Face) As shown on Drawings.
  9. Moisture Absorption: 3 percent, maximum
  10. Compressive Strength, Dry: 18,000 psi minimum.
  11. Dimensional Tolerances: Plus/minus 3/4 inch from specified dimension.
  12. Appearance: Natural quarried face without machine marks or scrapes.
- B. Concrete Wall Core and Foundation: Reinforced concrete with compressive strength of 3,000 psi minimum.
- C. Drainage backfill: Class 2 permeable backfill per Caltrans with Subsurface Drain system as described herein.

## **2.5 MORTAR**

- A. Consist of 1 part portland cement and 4 parts dry, loose sand. Add not less than 1/4 nor more than 1/2 part lime putty or hydrated lime per volume of cement content. Insure mortar with 28-day strength of at least 1500 psi.

## **2.6 GROUT**

- A. Consist of 1 part portland cement and 3 parts sand. Add up to 10% lime. When the grout core is 2" or more wide, add 2 parts of pea gravel to the above grout mix. Add water to grout to cause it to flow without segregation into all voids intended to be filled, and to produce a 28-day strength of 2000 psi. Plaster sand may be added to prevent segregation, provided strength is maintained. Color: medium to light gray color added to mortar. Submit color samples for acceptance by Resident Engineer.

## **2.7 REINFORCING MATERIALS**

- A. New, free of rust, Billet steel bars: Current ASTM designation A615.
- B. Bar Reinforcement: ASTM A615.
1. #3 and smaller: Grade 40.
  2. #4 and larger: Grade 60.
  3. Tie wire: #6 minimum, black and annealed.
- C. Bar Reinforcement recycled content shall be a minimum of 75% recycled post consumer steel.
- D. All anchors, dowels and other anchoring devices and shims shall be standard building stone anchors commercially available in a non-corrosive material such as zinc plated, galvanized steel, brass, or stainless steel Type 302 or 304.

## **2.8      ANCILLARY MATERIALS**

- A.    Dampproofing:    Per CALTRANS Standard Specifications, Section 54.
- B.    Subsurface Drain behind Retaining-Type Walls:    All walls that retain 30 inches of soil or more shall include a subsurface drainage system to relieve water pressure in accordance with Section 68 of the CALTRANS Standard Specifications and as shown.    If no subsurface drain is shown, provide corrugated polyethylene plastic tubing per 68-1.02K surrounded with an envelope of Class 2 permeable material per 68-1.025 and wrapped with filter fabric per 68-1.028.    Connect drains to storm drain system as accepted by Resident Engineer.

## **PART 3 - EXECUTION**

### **3.1      PREPARATION**

- A.    Provide testing and subgrade preparation complete.
- B.    Provide subgrade preparation and the base material installation complete, including clearing, grading, excavation, filling and dewatering.    Take every precaution to obtain a subgrade of uniform bearing power compacted to a minimum of 95% relative compaction as determined by the ASTM D1557 laboratory test procedure and in Sections 19 and 20 of the Caltrans Standard Specifications.
- C.    Do any necessary finish grading and compaction in addition to that performed in accordance with earthwork to bring subgrades after final compaction to required grades and sections as indicated.    Place no material on muddy subgrade.    Remove un-compactable material and replace with clean fill and compact as required.
- D.    Excavate to lines and grades shown on Drawings.    Do not disturb embankment or foundation beyond lines.    Minimize over-excavation.
- E.    After excavation and prior to placement of leveling materials, Contractor's Geotechnical engineer shall examine bearing soil surface to verify strength meets or exceeds design requirement and assumptions and issue report to Resident Engineer for acceptance.    Replace any unsuitable bearing soil as directed by Geotechnical Engineer.

### **3.2      REINFORCEMENT**

- A.    Concrete wall and footing shall be steel reinforced

### **3.3      INSTALLATION**

- A.    Install in accordance with Drawings and applicable codes and regulations.
  - 1.    Erection Tolerances:
    - a.    Variation for plane may be 1/2".
    - b.    Offset from true alignment between two connecting members may be 1/2" maximum.

2. Mortar joints as shown on drawings. Recess mortar joints minimum 3/4" inch. Provide pitch on horizontal joints to drain. Strike all joints to provide dense mortar.
3. Place first course of units on concrete foundation; check alignment and level. Check for full contact with base and for stability.
4. Place units side by side aligning face of wall using string line or offset from base line.
5. Insert anchoring devices as required. Check for proper alignment and batter. Place succeeding courses.

B. Setting Stones:

1. Distribute stones as shown on drawings.
2. Brush free of dust or other foreign matter and thoroughly wet before placing. Set in full mortar beds.
3. Provide sufficient number of stones to install complete wall from lines and grades shown on the drawings and details.

**3.4 DAMPPROOFING**

- A. Mop apply one heavy coat of asphalt to a minus 2 inches below finished soil grade on soil side of retaining wall.

**3.5 CLEANUP:**

- A. Exercise care that no mortar or grout comes in contact with exposed face of work. Clean immediately.
- B. Use only stiff fiber brushed and wooden scrapers in keeping work clean as it progresses or in cleaning down at completion. Use no metal implements.

**3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -

**SECTION 05 12 00**

**STRUCTURAL STEEL FRAMING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies structural steel shown and classified by Section 2, Code of Standard Practice for Steel Buildings and Bridges.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- D. Painting: Section 09 91 00, PAINTING.
- E. Steel Joist: Section 05 21 00, STEEL JOIST FRAMING.
- F. Steel Decking: Section 05 31 00, STEEL DECKING.
- G. Composite Steel Deck: Section 05 36 00, COMPOSITE METAL DECKING.
- H. Fireproofing: Section 07 81 00, APPLIED FIREPROOFING.

**1.3 QUALITY ASSURANCE:**

- A. Fabricator and erector shall maintain a program of quality assurance in conformance with Section 8, Code of Standard Practice for Steel Buildings and Bridges. Work shall be fabricated in an AISC certified CategoryComplex Steel Building Structures fabrication plant. Quality Assurance Plan shall also be in conformance with Appendix Q of AISC 341 for the Seismic Load Resisting System. Work to be performed by a fabricator certified under the AISC Quality Certification Program and an erector certified under the AISC Erector Certification Program as described below.
  - 1. Steel Fabricators - shall be a qualified fabricator who participates in the AISC certification program and is designated an AISC Certified Plant, Category STD. Fabricators that do not participate in the AISC certification program must present documentation to demonstrate equivalent quality management process and procedures that will be reviewed by the resident engineer as part of the pre-fabrication/pre-erection conference noted in Section 05 12 00 - Article 3.8, item A. All of the following elements must be in place to be considered as demonstrating equivalence:

- a. All welders are qualified per American Welding Society (AWS) D1.1. Documentation of welder qualification is available for review by inspection personnel.
  - b. Written welding procedures, compliant with AWS D1.1 specifications, are provided to, and used by all welders.
  - c. Written bolt tightening procedures, compliant with Research Council on Structural Connections (RCSC) specifications, are in provided for, and used in all bolting work.
  - d. Written procedures for contract and project specification review are provided to all individuals in the organization responsible to assure contract compliance. These procedures shall include a system for requests for information necessary to resolve discrepancies or variations from contract requirements.
  - e. Written procedures for inspection and the qualification of inspection personnel to verify that product quality meets project requirements. Inspection procedures shall meet AWS D1.1 requirements for "Contractor's Inspector" and RCSC requirements.
  - f. Written material procurement procedures are in place to ensure that material is ordered in accordance with design drawings and specifications.
  - g. Written inspection procedures are in place to ensure material received meets the purchase order and ASTM requirements.
  - h. Written procedures for correction of non-conforming work are provided to, and used by all shop personnel performing such work.
2. Steel Erectors - shall be a qualified erector who participates in the AISC certification program and is designated an AISC Certified Steel Erector (CSE). Erectors that do not participate in the AISC certification program must present documentation to demonstrate equivalent quality management process and procedures that will be reviewed by the resident engineer as part of the pre-fabrication/pre-erection conference noted in Section 05 12 00 - Article 3.8, item A. All of the following elements must be in place to be considered as demonstrating equivalence:
  - a. All welders are qualified per American Welding Society (AWS) D1.1. Documentation of welder qualification is available for review by inspection personnel.
  - b. Written welding procedures, compliant with AWS D1.1 specifications, are provided to, and used by all welders.
  - c. Written bolt tightening procedures, compliant with Research Council on Structural Connections (RCSC) specifications, are in provided for, and used in all bolting work.
  - d. Written procedure for fall protection is provided for and periodically updated and recorded by a person trained in fall protection and authorized to require needed corrections to the procedure.
  - e. All crane operators are CCO certified and equivalently trained and/or experienced.
  - f. Project specific erection plans with written hoisting and erection requirements are provided for and used in the field.
  - g. Written documentation of safety orientation for newly hired workers.



- h. Written procedures for contract and project specification review are provided to all individuals in the organization responsible to assure contract compliance. These procedures shall include a system for requests for information necessary to resolve discrepancies or variations from contract requirements.
  - i. Written procedures for inspection and the qualification of inspection personnel to verify that product quality meets project requirements. Inspection procedures shall meet AWS D1.1 requirements for "Contractor's Inspector" and RCSC requirements.
  - j. Written procedures for correction of non-conforming work are provided to, and used by all field personnel performing such work.
- B. Before authorizing the commencement of steel erection, the Controlling Contractor shall ensure that the steel erector is provided with the written notification required by 29 CFR 1926.752. Provide copy of this notification to the Resident Engineer.
- C. Additional quality assurance requirements for members and connections of the Seismic Load Resisting System (SLRS) shall be made in accordance with the requirements of AISC 341 and AWS D1.8.

#### **1.4 TOLERANCES:**

- A. Fabrication tolerances for structural steel shall be held within limits established by ASTM A6, by Section 7, Code of Standard Practice for Buildings and Bridges, and by Standard Mill Practice - General Information (AISC Steel Construction Manual, Thirteenth Edition, Page 1-9), except as follows:
  - 1. Elevation tolerance for column splice points at time member is erected is 10 mm (3/8 inch).
  - 2. Elevation tolerance for top surface of steel beams and girders at connections to columns at time floor is erected is 13 mm (1/2 inch).
  - 3. Elevation tolerance for closure plates at the building perimeter and at slab openings prior to concrete placement is 6 mm (1/4 inch).

#### **1.5 DESIGN:**

- A. Cooling Tower Supports: Unless otherwise shown on the Contract Documents, the design, location, and dimensions of cooling tower supports are based upon a typical installation. Contractor shall furnish and install at no additional cost to the Government, adequate structural supports for equipment furnished for this installation. Design shall be based on loads supplied by the Cooling Tower Manufacturer and must include an allowance for wind and seismic lateral loads. Submit detailed drawings and design calculations, prepared by a Professional Engineer registered in the State of California, for approval before members are fabricated.

#### **1.6 REGULATORY REQUIREMENTS:**

- A. AISC: Specification for Structural Steel Buildings.

- B. AISC: Code of Standard Practice for Steel Buildings and Bridges, modified as follows.
  - 1. Section 3. - Design Drawings and Specifications, Paragraph 3.3 Discrepancies, Delete the paragraph: "When discrepancies exist between the Design Drawings and Specifications, the Design Drawings shall govern..."
  - 2. Section 4 - Approval, Paragraph 4.4.1; Delete subparagraph (b) "Confirmation that the Owner's Designated Representative for Design has reviewed and approved the Connection details shown on the Shop and Erection Drawings..."
- C. AISC: Seismic Provisions for Structural Steel Buildings.

**1.7 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop and Erection Drawings: Include complete details, schedules, procedures and diagrams for fabrication and assembly of structural steel members. Provide all dimensional and geometric information, grade of steel, shop surface treatments and shop connections. Shop drawings shall not be reproductions of the Contract Drawings. Include details of cuts, connections, camber, holes, and other pertinent data. Indicate welds by standard AWS symbols, and show size, length, and type of each weld. Clearly distinguish between shop and field welds. Clearly indicate welds that are designated as Demand Critical (DC) and part of the SLRS (CVN). Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorage. Indicate profiles, sizes, spacing, lengths and locations of structural members, indicating stiffener and continuity plates, bolts, fasteners, welds and attachments. Indicate where backing bars are to be removed and locations where weld tabs are to be removed.
- C. Certificates (all to be provided in English):
  - 1. Structural steel.
  - 2. Steel for all connections.
  - 3. Welding materials.
  - 4. Shop coat primer paint.
  - 5. High strength bolts
- D. Test Reports:
  - 1. Welders' qualifying tests.
- E. Design Calculations and Drawings:
  - 1. Connection calculations, if required.
  - 2. Cooling Tower Supports: If not designed on the Structural Drawings.
- F. Record Surveys

- G. Review of submittals and shop drawings covers only the general scheme and character of the details. Such review does not relieve the Contractor from responsibility for executing the work in accordance with the contract documents.
- H. Wedge and Adhesive Anchor Product Data:
  - 1. Manufacturers data to include description, type, reference numbers, sizes, installation methods and design values recognized by testing agency.
  - 2. ICC-ES reports showing compliance with specified criteria.
- I. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.8 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Institute of Steel Construction (AISC):
  - 1. Specification for Structural Steel Buildings, 2005, (AISC 360-05).
  - 2. Code of Standard Practice for Steel Buildings and Bridges, 2005, (AISC 341-05)
  - 3. Seismic Provisions for Structural Steel Buildings, Including Supplement No. 1, 2005 (AISC 341-05).
  - 4. Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications, 2005, (AISC 358-05).
  - 5. Steel Construction Manual, Thirteenth Edition, 2005.
- C. American National Standards Institute (ANSI):
  - 1. B18.22.1-98 Plain Washers
  - 2. B18.22M-00 Metric Plain Washers
  - 3. 23.1-98 Beveled Washers
- D. American Society for Testing and Materials (ASTM):
  - 1. A6/A6M-04a Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
  - 2. A36/A36M-04 Standard Specification for Carbon Structural Steel
  - 3. A53/A53M-02 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

4. A108/A108M-07 Standard Specification for Steel Bar, Carbon and Alloyed, Cold-Finish
5. A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. A242/A242M-04 Standard Specification for High-Strength Low-Alloy Structural Steel
7. A283/A283M-03 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
8. A307-03 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
9. A325-04 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
10. A435/435M-01 Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates
11. A490-04 Standard Specification for Heat-Treated Steel Structural Bolts 150 ksi Minimum Tensile Strength
12. A500-03a Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
13. A501-01 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
14. A572/A572M-04 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
1. A780-06 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
15. A898/898M-01 Standard Specification for Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes
16. A992/A992M-02 Standard Specification for Structural Steel Shapes
17. C1107-05 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
18. F436-04 Standard Specification for Hardened Steel Washers
19. F844-04e1 Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
20. F1554-04 Standard Specification for Anchor Bolts, Steel, 36,55 and 105 ksi Yield Strength
21. F1852-08 Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

E. American Welding Society (AWS):

1. D1.1/D1.1M-04 Structural Welding Code-Steel
2. D1.8/D1.8M-05 Structural Welding Code - Seismic Supplement
3. C4.1-G Oxygen Cutting Surface Roughness Gauge
4. C4.1-WC Criteria for Describing Oxygen-Cut Surfaces

- F. Research Council on Structural Connections (RCSC) of The Engineering Foundation:
  - 1. Specification for Structural Joints Using ASTM A325 or A490 Bolts
- G. Military Specifications (Mil. Spec.):
  - 1. MIL-P-21035 Paint, High Zinc Dust Content, Galvanizing, Repair
- H. Occupational Safety and Health Administration (OSHA):
  - 1. 29 CFR Part 1926-2001 Safety Standards for Steel Erection

## **1.9 DEFINITIONS**

- A. Seismic Load Resisting System (SLRS) - assembly of structural elements that resist seismic forces including columns, beams, braces, collectors, shear walls, and the interconnections between the elements. The SLRS does not include elements that provide out-of-plane bracing to components of the SLRS nor components designed to resist gravity loads only.
- B. Demand Critical Welds (DC)- structural welds identified on the drawings applicable to the designated SLRS. All welds that are part of the SLRS are demand critical welds unless specifically indicated otherwise.
- C. Protected Zones - portions of the BRB and bracing connections where miscellaneous connections such as tack welds, erection aids, shear studs, decking attachments, bolts, screws or other such attachments are prohibited.
- D. Building SLRS Descriptions:
  - 1. Cogen Building: The SLRS for the CoGen building consists of a concrete on deck roof diaphragm laterally supported by the exterior concrete tilt-up walls of the building.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS:**

- A. Structural Steel Angles and Channels: ASTM A36.
- B. Steel W Shapes and Tees: ASTM A992.
- C. Structural Tubing: ASTM A500, Grade B.
- D. Steel Pipe: ASTM A53, Grade B.
- B. Steel Plates: ASTM A36 or ASTM A572, Grade 50, as indicated on the drawings.
- E. Bolts, Nuts and Washers:
  - 1. High-strength bolts, including nuts and washers: ASTM A325. High strength bolts are typical, unless otherwise noted on the drawings.
  - 2. Bolts and nuts, other than high-strength: ASTM A307, Grade A.

- 3. Plain washers, other than those in contact with high-strength bolt heads and nuts: ANSI Standard B18.22.1.
- 4. High-strength bolts, twist-off assemblies: ASTM F1852.
- F. Zinc Coating: ASTM A123.
- G. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035.
- H. Anchor Rods: ASTM A1554, Grade as indicated on the drawings, with matching ASTM A563 nuts and ASTM F436 Type 1 washers.
- I. Shear Connectors (Automatic End Welded Studs): Headed stud type, ASTM A 108, Grade 1015 through 1020, cold finished low-carbon steel, minimum tensile strength of 60,000 psi; sizes and numbers as indicated, and dimensions complying with AISC Specifications
- J. Welding materials: AWS D1.1; type required for materials being welded. Electrodes to be low hydrogen E7XTX, E7XTXX or E70XXX as applicable.
  - 1. Welds that are part of the SLRS are to meet CVN toughness requirements in accordance with Section 7.3a of AISC 341.
    - a. Welds designated as Demand Critical (DC) on the drawings shall also meet the additional requirements of Section 7.3b of AISC 341.
- C. Grout: Non-shrink, non-metallic aggregate type, complying with ASTM C1107 and capable of developing a minimum compressive strength of 7,000 psi (48 MPa) at 28 days.
- K. Wedge Anchors: Tested and qualified for use in cracked concrete per ACI 355.2 and ICC-ES AC 193. Anchors to have a current ICC-ES report approved for cracked concrete (seismic) use under the 2006 IBC. Install anchors in accordance with the ICC-ES report and manufacturers instructions. Provide stainless steel anchors for exterior use or when exposed to weather. Provide galvanized carbon steel anchors at other locations, unless otherwise noted.
- L. Adhesive Anchors: Tested and qualified for use in cracked concrete per ACI 355.2 and ICC-ES AC 308. Anchors to have a current ICC-ES report approved for cracked concrete (seismic) use under the 2006 IBC. Install anchors in accordance with the ICC-ES report and manufacturers instructions. Provide hot-dip galvanized anchors for exterior use or when exposed to weather.

### **PART 3 - EXECUTION**

#### **3.1 CONNECTIONS (SHOP AND FIELD):**

- A. Welding: Welding in accordance with AWS D1.1. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.
- B. High-Strength Bolts: High-strength bolts tightened to a bolt tension not less than proof load given in Specification for Structural Joints Using

ASTM A325 or A490 Bolts. Tightening done with properly calibrated wrenches, by turn-of-nut method or by use of direct tension indicators (bolts or washers). Tighten bolts in connections identified as slip-critical using Direct Tension Indicators or the turn-of-the-nut method.

- C. For the Seismic Load Resisting System (SLRS), additional welding and bolting requirements are to be followed as required in AWS D1.8 Seismic Supplement and AISC 341 - Seismic Provisions, and these provisions.

### **3.2 FABRICATION:**

- A. Fabrication and quality Control in accordance with Chapter M of AISC 360.
- B. At beams supporting metal deck with concrete fill, space shear connectors at 12 inches on center, unless otherwise noted.
- D. Fabricate structural steel in one location, by one fabricator.
- C. Provide camber for beams and girders as noted on drawings. Where no camber is noted, provide natural camber up, except at cantilevers. Coordinate all Fabrication and QC activities with Quality Assurance activities to be performed by the Testing Laboratory identified in Section 01 45 29 of this Specification. Provide Testing Laboratory personnel with schedule, access, and documentation needed to ensure that testing activities can be performed without undue delay to the work.
- D. Field cutting or other alteration of structural steel is not allowed without prior approval of the Resident Engineer.
- E. Repair galvanized steel in accordance with ASTM A 780
- F. Grout solidly between steel base and end plates and concrete bearing surfaces, complying with manufacturer's instructions for non-shrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.
- G. Welding Procedure Specification (WPS) written for each weld used on the project before the start of work. Include all information required by AWS D1.1 and the Sample Welding Form given in the Annex to AWS D1.1, including the power source and for demand critical welds, electrode manufacturer and trade name. Record the name of the individuals responsible for the suitability of the WPS on the WPS. Written procedure for back gouging, grinding, re-welding and the application of the reinforcing fillets as required for the completed weld.
- H. Procedure Qualification Records (PQR) for WPS's that are not pre-qualified per AWS D1.1 prior to the start of work. Submit a PQR for each weld made up of a combination of different welds and/or filler metals, even if those welds are individually qualified or prequalified.
- I. Distortion Control Program -specify welding sequence requirements for connections between beams and columns. Include the sequence of flange and web welding and bolting to maintain alignment of structural steel members where applicable.

- J. Contractor is solely responsible for the quality of the work.
- K. Shear connector welding: AWS D1.1.
  - 1. Do not shop weld studs to top flanges of floor beams. Field install studs after metal decking surface has been installed.
  - 2. Weld studs with automatically timed stud welding equipment connected to suitable source of direct current electrode negative power. Calibrate voltage, current, time, and gun settings for optimal welding based on manufacturer's recommendations
- L. Shop fabricate structural steel to the greatest extent possible. Where permissible, hot-dip galvanize members in completed assemblies.

### **3.3 SHOP PAINTING:**

- A. General: Shop paint steel with primer in accordance with Section 6, Code of Standard Practice for Steel Buildings and Bridges.
- B. Shop paint for steel surfaces is specified in Section 09 91 00, PAINTING.
- C. Do not apply paint to following:
  - 1. Surfaces within 50 mm (2 inches) of joints to be welded in field.
  - 2. Surfaces which will be encased in concrete.
  - 3. Surfaces which will receive sprayed on fireproofing.
  - 4. Top flange of members which will have shear connector studs applied.
- D. Zinc Coated (Hot Dip Galvanized) per ASTM A123 (after fabrication):  
Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.
- E. Galvanize all exterior structural steel members, connections and fasteners. This includes, but is not limited to cooling tower supports.
- F. Members to receive intumescent coatings as required in Division 9 shall not have shop applied primer unless specifically required by the manufacturer.

### **3.4 ERECTION:**

- A. General: Erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges and Chapter M of AISC 360.
- B. Temporary Supports: Temporary support of structural steel frames during erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges.
- C. The use of Post Weld Heat Treatment (PWHT) is permitted at the Contractor's option, but is not required. The use of PWHT shall meet the Stress-Relief Heat Treatment limitations of AWS D1.1, Section 5.8, and shall be used as needed to produce quality welds. The use of peening is permitted at the



Contractor's option, but not required. Provide a written procedure for performing peening incorporated into the WPS for the joints to be peened.

- D. Non-fusible backing: Nonfusible backing materials, including ceramic and copper: permitted only with satisfactory welder qualification testing performed using the type of backing proposed for use, using the test plate shown in AWS D1.1-98, Figure 4.21, except that groove dimensions shall be as provided in the WPS and PQR. Should the joint include welding a beam flange to a column flange through an access hole, perform Supplementary Welder Qualification Test of Appendix B using the type of proposed backing material. Nonfusible weld tabs and short segments of nonfusible backing bars used at the ends of welds between shear tabs and column faces, or at the ends of continuity plate welds, special welding personnel and welding procedure qualification testing is not required. The welder shall be trained in the proper welding techniques for using such nonfusible weld tabs and backing bars prior to performing such welding on the project.

### **3.5 FIELD PAINTING:**

- A. After erection, touch-up steel surfaces specified to be shop painted. After welding is completed, clean and prime areas not painted due to field welding.
- B. Finish painting of steel surfaces is specified in Section 09 91 00, PAINTING.
- C. Repair galvanized steel in accordance with ASTM A780.

### **3.6 ADDITIONAL REQUIREMENTS FOR FABRICATION AND ERECTION OF MEMBERS AND CONNECTIONS OF THE SEISMIC LOAD RESISTING SYSTEM (SLRS)**

- A. Members and connections of the SLRS (as noted on the drawings) shall meet additional fabrication and erection requirements for both welding and bolting as specified in the following Sections of AISC 341 and AISC 358 (where noted):
1. 5.2. - Shop Drawings
  2. 5.3. - Erection Drawings
  3. 6.1. - Material Specifications
  4. 6.3. - Heavy Section CVN Requirements
  5. 7.2. - Bolted Joints
  6. 7.3. - Welded Joints (including all subsections)
  7. 7.4. - Protected Zone
  8. 7.5. - Continuity Plates and Stiffeners
  9. W2.2 - Shop Drawings
  10. W2.3 - Erection Drawings
  11. W5 - Additional Welding Provisions (including all subsections)

12. W6 - Additional Welding Provisions for Demand Critical Welds Only (including all subsections)

### **3.7 ADDITIONAL REQUIREMENTS FOR QUALITY CONTROL (QC) OF MEMBERS AND CONNECTIONS OF THE SEISMIC LOAD RESISTING SYSTEM (SLRS)**

- A. Members and connections of the SLRS shall meet additional quality control tasks and documentation for both welding and bolting as specified in the following Sections of AISC 341:
  1. Q.3. - Contractor Documents
  2. Q.5. - Inspection Points and Frequencies, all tasks noted as "QC" (including all subsections)
  3. W3.1 - QC Welding Inspectors

### **3.8 PRE-FABRICATION/PRE-ERECTION CONFERENCE:**

- A. Pre-Fabrication / Pre-Erection Conference: Prior to fabrication and following WPS approvals, convene a pre-construction meeting, or series of meetings to review fabrication and erection methods, submittals, sequencing, and testing and inspection as required. At least one such meeting shall be held prior to the start of both fabrication and erection. Representatives of Contractor's fabrication and erection personnel, Contractor's QC personnel, Testing Laboratory personnel, Resident Engineer, members of the Design Team and all other interested parties are to attend these meetings.

### **3.9 SURVEY:**

- A. Prior to the submittal of any shop drawings for structural steel base plates or columns, a survey of all existing anchor rod locations and elevations shall be performed by a Land Surveyor or Civil Engineer registered in the State of California and submitted to the Resident Engineer. The Contractor shall retain and pay for these services in accordance with Section 10 00 00 of these specifications. The survey shall identify all anchor rod locations that do not comply with the tolerance limits specified in this Section, and the amount by which the anchor rod is out of tolerance. Resolution of anchor rod locations that do not meet these tolerance limits shall be made in accordance with Section 10 00 00, GENERAL REQUIREMENTS, of these specifications. See also "SURVEY" portion of Section 10 00 00 of these specifications. Erection of columns and base plates will not be permitted until all such discrepancies are resolved and approved by the Resident Engineer. Reports shall be prepared by a Registered Land Surveyor or Registered Civil Engineer as specified in Section, 10 00 00, GENERAL REQUIREMENTS. Report shall specify that location of structural steel and anchor rods is acceptable for plumbness, level and alignment within specified tolerances specified in the AISC Code of Standard Practice.
- B. Upon completion of finish bolting or welding on any part of the work, and prior to start of work by other trades that may be supported, attached, or applied to the structural steel work, submit a certified report of survey to Resident Engineer for approval. Reports shall be prepared by Registered Land Surveyor or Registered Civil Engineer as specified in Section 01 00 00, GENERAL REQUIREMENTS. Report shall specify that location of structural

steel is acceptable for plumbness, level and alignment within specified tolerances specified in the AISCCode of Standard Practice and the requirements of this Section.

### **3.10 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 05 36 00**

**COMPOSITE METAL DECKING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies material and services required for installation of composite steel decking including[ **shear connector studs and**] miscellaneous closures required to prepare deck for concrete placement as shown and specified.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: Shop and erection drawings showing decking unit layout, connections to supporting members, and information necessary to complete the installation as shown and specified, including supplementary framing, cant strips, cut openings, special jointing or other accessories. Show welding, side lap, closure, deck reinforcing and closure reinforcing details. Show openings required for work of other trades, including openings not shown on structural drawings. Indicate where temporary shoring is required to satisfy design criteria.
- C. Manufacturer's Literature and Data: Showing steel decking section properties and specifying structural characteristics as specified herein.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

- E. Manufacturer's written recommendations for:
  - 1. Cleaning of steel decking prior to concrete placement.
- F. Test Report - Establishing structural characteristics of composite concrete and steel decking system.
- G. Test Report - Stud base qualification.
- H. Welding power setting recommendation by shear stud manufacturer.
- I. Shear Stud Layouts: Submit drawings showing the number, pattern, spacing and configuration of the shear studs for each beam and girder.
- J. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.
- K. Certification: For each type and gauge of metal deck supporting concrete slab or fill, furnish certification of the specified fire ratings. Certify that the units supplied are U.L. listed as a "Steel Floor and Form Unit".

#### **1.4 QUALITY ASSURANCE**

- A. Underwriters' Label: Provide metal floor deck units listed in Underwriters' Laboratories "Fire Resistance Directory", with each deck unit bearing the UL label and marking for specific system detailed.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.
- C. Welders and welding procedures to be qualified in accordance with AWS D1.1 and D1.3.

#### **1.5 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Refer to the latest edition of all referenced Standards and codes.
- B. American Iron and Steel Institute (AISI):
  - 1. Specification and Commentary for the Design of Cold-Formed Steel Structural Members (Latest Edition).
- C. American Society of Testing and Materials (ASTM):
  - 1. A36/A36M Standard Specification for Carbon Structural Steel
  - 2. A108 Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality
  - 3. A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process

- D. American Institute of Steel Construction (AISC):
  - 1. Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design (Latest Edition)
  - 2. Load and Resistance Factor Design Specification for Structural Steel Buildings (Latest Edition)
- E. American Welding Society (AWS):
  - 1. D1.1 Structural Welding Code - Steel
  - 2. D1.3 Structural Welding Code - Sheet Steel
- F. Military Specifications (Mil. Spec.):
  - 1. MIL-P-21035B Paint, High Zinc Dust Content, Galvanizing Repair

**1.6 DELIVERY, STORAGE AND HANDLING:**

- A. Deliver, store and handle decking in a manner to prevent damage or deformation.
- B. Cut plastic wrap to encourage ventilation.
- C. Store deck on dry wood sleepers; slope for positive drainage.

**PART 2 - PRODUCTS**

**2.1 MATERIALS:**

- A. Steel Decking and all Flashings: ASTM A653, Structural Quality suitable for shear stud weld-through techniques.
- B. Galvanizing: ASTM A653, G90.
- C. Shear connector studs: ASTM A108, Grades 1015-1020, yield 350 Mpa (50,000 psi) minimum, tensile strength - 400 Mpa (60,000 psi) minimum, reduction of area 50 percent minimum. Studs of uniform diameter; heads shall be concentric and normal to shaft; stud, after welding free from any substance or defect which would interfere with its function as a shear connector. Studs shall not be painted or galvanized. Size of studs shall be as shown on drawings. Studs manufactured by a company normally engaged in the manufacturer of shear studs and can furnish equipment suitable for weld-through installation of shear studs.
- D. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035B.
- E. Miscellaneous Steel Shapes, Bearing Plates, Bent Plates and Angles: ASTM A36.
- F. Welding Materials: AWS D1.1; type for materials being welded. Electrodes to be low hydrogen type E7XTX, E7XTXX, or E70XXX as applicable.

- G. Sheet Metal Accessories: ASTM A653, galvanized, unless noted otherwise. Provide accessories of every kind required to complete the installation of metal decking in the system shown. Finish sheet metal items to match deck including, but not limited to, the following items:
1. Metal Cover Plates: For end-abutting deck units, to close gaps at changes in deck direction, columns, walls and openings. Same quality as deck units but not less than 1.3 mm (18 gauge) sheet steel.
  2. Continuous sheet metal edging: at openings and concrete slab edges, unless otherwise detailed on drawings. Same quality as deck units but not less than 1.3 mm (18 gauge) steel. Side and end closures supporting concrete and their attachment to supporting steel shall be designed by the manufacturer to safely support the wet weight of concrete and construction loads. The deflection of cantilever closures shall be limited to 3 mm (1/8 inch) maximum.
  3. Metal Closure Strips: For openings between decking and other construction, of not less than 1.3 mm (18 gauge) sheet steel of the same quality as the deck units. Form to the configuration required to provide tight-fitting closures at open ends of flutes and sides of decking.
  4. Seat angles for deck: Where a beam does not frame into a column.

## **2.2 REQUIREMENTS:**

- A. Steel decking depth, gage, and section properties to be as shown on the drawings. Provide edges of deck with vertical interlocking male and female lip providing for a positive mechanical connection.
- B. Fabricate deck units with integral embossments to provide mechanical bond with concrete slab. In combination with concrete slab, capable of supporting total design loads on spans shown.
- C. Steel decking capable of safely supporting total, normal construction service loads without damage to decking unit.
- D. Steel decking units shall include an integral system which provides a simple point of attachment for light duty hanger devices for flexibility for attaching hangers for support of acoustical, lathing, plumbing, heating, air conditioning and electrical items. System shall provide for minimum spacing pattern of 300 mm (12 inches) on centers longitudinally and 600 mm or 900 mm (24 or 36 inches) on centers transversely. Suspension system shall be capable of safely supporting a maximum allowable load of 45 kg (100 pounds) concentrated at any one hanger attachment point. System may consist of fold-down type hanger tabs or a lip hanger.

## **PART 3 - EXECUTION**

### **3.1 ERECTION:**

- A. Do not start installation of metal decking until corresponding steel framework has been plumbed, aligned and completed and until temporary shoring, where required, has been installed. Remove any oil, dirt, paint,



ice, water and rust from steel surfaces to which metal decking will be welded.

- B. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
- C. Do not use floor deck units for storage or working platforms until permanently secured. Do not overload deck units once placed. Replace any deck units that become damaged after erection and prior to casting concrete at no cost to the Government.
- D. Erect steel deck in accordance with manufacturer's printed instructions.
- E. Ship steel deck units to project in standard widths and cut to proper length.
- F. Provide steel decking in sufficient lengths to extend over 3 or more spans, except where structural steel layout does not permit.
- G. Place steel decking units on supporting steel framework and adjust to final position before being permanently fastening. Bring each unit to proper bearing on supporting beams. Place deck units in straight alignment for entire length of run of flutes and with close registration of flutes of one unit with those of abutting unit. Maximum space between ends of abutting units is 13 mm (1/2 inch). If space exceeds 13 mm (1/2 inch), install closure plates at no additional cost to Government.
- H. Ceiling hanger loops, if used, must be flattened or removed to obtain bearing of units on structural steel.
- I. Fastening Deck Units to structural steel as indicated on the drawings.
- J. Welding to conform to AWS D1.3 and done by competent experienced welding mechanics.
- K. Areas scarred during erection and welds shall be thoroughly cleaned and touched-up with zinc rich galvanizing repair paint. Paint touch-up is not required for welds or scars that are to be in direct contact with concrete.
- L. Provide metal concrete stops at edges of deck as required.
- M. Cutting and Fitting:
  - 1. Cut all metal deck units to proper length in the shop prior to shipping.
  - 2. Field cutting by the metal deck erector is restricted to bevel cuts, notching to fit around columns and similar items, and cutting openings that are located and dimensioned on the structural drawings.
  - 3. Other penetrations shown on the approved metal deck shop drawings but not shown on the structural drawings are to be located, cut and reinforced by the trade requiring the opening.
  - 4. Make all cuts neat and trim using a metal saw, drill or punchout device; cutting with torches is expressly prohibited.
  - 5. Do not make any cuts in the metal deck that are not shown on the approved metal deck drawings. If an additional opening not shown on the approved

shop drawings is required, submit a sketch, to scale, locating the required new opening and any other openings and supports in the immediate area. Do not cut the opening until the sketch has been reviewed and accepted by the Resident Engineer. Provide any additional reinforcing or framing required for the opening at no cost to the Government. Failure to comply with these requirements is cause for rejection of the work and removal and replacement of the affected metal deck.

6. Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking and support of other work shown.

N. Installation of shear connector studs through previously installed metal deck to conform to AWS D1.1, Section 7, except all studs will be installed with automatically timed welding equipment and as specified below:

1. Do not place reinforcing steel temperature mesh or other materials and equipment which will interfere with stud installation on steel deck until shear connector studs are installed.
2. Steel deck sheets shall be free of oil, rust, dirt, and paint. Release water in deck's valley so that it does not become entrapped between deck and beam. Surface to which stud is to be welded shall be clean and dry.
3. Rest metal deck tightly upon top flange of structural member with bottom of deck rib in full contact with top of beam flange.
4. Weld studs only through a single thickness of deck. Place decking so that a butt joint is obtained. Place studs directly over beam web, where one row of studs are required.
5. Ferrules specially developed for the weld-through technique must be used. Ferrules shall be appropriate for size of studs used and be removed after welding.
6. Submit report of successful test program for stud base qualification as required by AWS D1.1, Appendix K.
7. Space shear connector studs at 12 inches on center, unless otherwise noted.

### **3.2 CLEANING:**

- A. Clean deck in accordance with manufacturer's recommendation before concrete placement.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 05 50 00**

**METAL FABRICATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.
- B. Items specified.
  - 1. Support for wall and ceiling mounted items
  - 2. Gratings
  - 3. Ladders
  - 4. Guard rail/railings
  - 5. Pipe bollards (post barricades).

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Colors, finishes, and textures: Section 09 06 00, SCHEDULE FOR FINISHES.
- D. Prime and finish painting: Section 09 91 00, PAINTING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Grating, each type.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

D. Shop Drawings:

1. Each item specified, showing complete detail, location in the project, material and size of components, method of joining various components and assemblies, finish, and location, size and type of anchors.
2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
3. Provide templates and rough-in measurements as required.

E. Manufacturer's Certificates:

1. Anodized finish as specified.
2. Live load designs as specified.

F. Furnish setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

**1.4 QUALITY ASSURANCE**

- A. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.
- B. Assembled product to the greatest extent possible before delivery to the site.
- C. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
  1. B18.6.1-81 (R1997) Wood Screws
  2. B18.2.2-87 (R2005) Square and Hex Nuts
- C. American Society for Testing and Materials (ASTM):
  1. A36/A36M-05 Structural Steel
  2. A47-99 (R2004) Malleable Iron Castings
  3. A48-03 Gray Iron Castings
  4. A53-06 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  5. A123-02 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

6. A167-99(R2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
  7. A269-07 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  8. A307-07 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  9. A312/A312M-06 Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
  10. A391/A391M-01 Grade 80 Alloy Steel Chain
  11. A653/A653M-07 Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
  12. A786/A786M-05 Rolled Steel Floor Plate
  13. B221-06 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  14. B456-03 Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
  15. B632-02 Aluminum-Alloy Rolled Tread Plate
  16. C1107-07 Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
  17. D3656-04 Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
  18. F436-07 Hardened Steel Washers
  19. F468-06 Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
  20. F593-02 Stainless Steel Bolts, Hex Cap Screws, and Studs
  21. F1667-05 Driven Fasteners: Nails, Spikes and Staples
- D. American Welding Society (AWS):
1. D1.1-04 Structural Welding Code Steel
  2. D1.2-03 Structural Welding Code Aluminum
  3. D1.3-98 Structural Welding Code Sheet Steel
- E. National Association of Architectural Metal Manufacturers (NAAMM)
1. AMP521-01 Pipe Railing Manual
  2. AMP 500-505-1988 Metal Finishes Manual
  3. MBG 531-00 Metal Bar Grating Manual
  4. MBG 532-00 Heavy Duty Metal Bar Grating Manual
- F. Structural Steel Painting Council (SSPC):
1. SP 1-05 No. 1, Solvent Cleaning
  2. SP 2-05 No. 2, Hand Tool Cleaning
  3. SP 3-05 No. 3, Power Tool Cleaning

G. Federal Specifications (Fed. Spec):

1. RR-T-650E Treads, Metallic and Nonmetallic, Nonskid

## **PART 2 - PRODUCTS**

### **2.1 DESIGN CRITERIA**

- A. In addition to the dead loads, design fabrications to support the following live loads unless otherwise specified.
- B. Ladders and Rungs: 120 kg (250 pounds) at any point.
- C. Railings and Handrails: 900 N (200 pounds) in any direction at any point.

### **2.2 MATERIALS**

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Pipe: ASTM A53.
  1. Galvanized for exterior locations.
  2. Type S, Grade A unless specified otherwise.
  3. NPS (inside diameter) as shown.
- C. Primer Paint: As specified in Section 09 91 00, PAINTING.
- D. Modular Channel Units:
  1. Factory fabricated, channel shaped, cold formed sheet steel shapes, complete with fittings bolts and nuts required for assembly.
  2. Form channel with in turned pyramid shaped clamping ridges on each side.
  3. Provide case hardened steel nuts with serrated grooves in the top edges designed to be inserted in the channel at any point and be given a quarter turn so as to engage the channel clamping ridges. Provide each nut with a spring designed to hold the nut in place.
  4. Factory finish channels and parts with oven baked primer when exposed to view. Channels fabricated of ASTM A525, G90 galvanized steel may have primer omitted in concealed locations. Finish screws and nuts with zinc coating.
  5. Fabricate snap-in closure plates to fit and close exposed channel openings of not more than 0.3 mm (0.0125 inch) thick stainless steel.

### **2.3 HARDWARE**

- A. Rough Hardware:
  1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.

2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

B. Fasteners:

1. Bolts with Nuts:
  - a. ASME B18.2.2.
  - b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
  - c. ASTM F468 for nonferrous bolts.
  - d. ASTM F593 for stainless steel.
2. Screws: ASME B18.6.1.
3. Washers: ASTM F436, type to suit material and anchorage.

**2.4 FABRICATION GENERAL**

A. Material

1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
4. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.
5. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
6. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
7. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.

E. Workmanship

1. General:
  - a. Fabricate items to design shown.
  - b. Furnish members in longest lengths commercially available within the limits shown and specified.
  - c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
  - d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.
  - e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
  - f. Prepare members for the installation and fitting of hardware.
  - g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.
  - h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.
2. Welding:
  - a. Weld in accordance with AWS.
  - b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.
  - c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
  - d. Finish welded joints to match finish of adjacent surface.
3. Joining:
  - a. Miter or butt members at corners.
  - b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.
4. Cutting and Fitting:
  - a. Accurately cut, machine and fit joints, corners, copes, and



miters.

- b. Fit removable members to be easily removed.
- c. Design and construct field connections in the most practical place for appearance and ease of installation.
- d. Fit pieces together as required.
- e. Fabricate connections for ease of assembly and disassembly without use of special tools.
- f. Joints firm when assembled.
- g. Conceal joining, fitting and welding on exposed work as far as practical.
- h. Do not show rivets and screws prominently on the exposed face.
- i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

F. Finish:

- 1. Finish exposed surfaces in accordance with NAAMM Metal Finishes Manual.
- 2. Steel and Iron: NAAMM AMP 504.
  - a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
  - b. Surfaces exposed in the finished work:
    - 1) Finish smooth rough surfaces and remove projections.
    - 2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
  - c. Shop Prime Painting:
    - 1) Surfaces of Ferrous metal:
      - a) Items not specified to have other coatings.
      - b) Galvanized surfaces specified to have prime paint.
      - c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.
      - d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.
      - e) After cleaning and finishing apply one coat of primer as specified in Section 09 91 00, PAINTING.
    - 2) Non ferrous metals: Comply with MAAMM-500 series.

G. Protection:

- 1. Insulate aluminum surfaces that will come in contact with concrete, masonry, plaster, or metals other than stainless steel, zinc or white bronze by giving a coat of heavy-bodied alkali resisting bituminous paint or other approved paint in shop.

## **2.5 SUPPORTS**

### **A. General:**

1. Use clip angles or make provisions for welding hangers and braces to overhead construction.
2. Field connections may be welded or bolted.
3. Structural steel tube or channel for grab bar at water closets floor to structure above with clip angles or end plates formed for anchors.
4. Use steel angles for thru wall counters. Drill angle for fasteners at ends and not over 100 mm (4 inches) on center between ends.

### **B. For Trapeze Bars:**

1. Use modular channel where shown with manufacturers bolts and fittings.
  - a. Weld ends of steel angle braces to steel plates and secure to modular channel units as shown. Drill plates for anchor bolts.
  - b. Fabricate eye bolt, special clamp bolt, and plate closure full length of modular channel at ceiling line and secure to modular channel unit with manufacturers standard fittings.

## **2.6 MECHANICAL TRENCH GRATINGS**

### **A. Provide clearance at all sides to permit easy removal of grating.**

### **B. Make cutouts in gratings with 6 mm (1/4 inch) minimum to 25 mm (1 inch) maximum clearance for penetrations or passage of pipes and ducts. Edge band cutouts.**

### **C. Fabricate in sections not to exceed 2.3 m<sup>2</sup> (25 square feet) in area and 90 kg (200 pounds) in weight.**

### **D. Steel Bar Gratings:**

1. Dimensions:
  - a. Bearing Bar Spacing: 11/16 inch (17 mm)
  - b. Bearing Bar Depth: 1 inch (25 mm)
  - c. Bearing Bar Thickness: 3/16 inch (4.8 mm)
  - d. Crossbar Spacing: 4 inches (102 mm)] o.c.
2. Fabricate grating using steel bars, frames, supports and other members shown in accordance with Metal Bar Grating Manual.
3. Galvanize steel members after fabrication in accordance with ASTM A123, minimum 355 g/m<sup>2</sup> (1.2 oz/ft<sup>2</sup>) coating thickness.

## **2.7 LADDERS**

### **A. Aluminum Ladders:**

1. Fixed-rail type, constructed of structural aluminum, with mill finish.
2. Fabricate side rails and rungs of size and design shown, with the rungs shouldered and headed into and welded to the rails.

3. Where shown fabrication side rails curved, twisted and formed into gooseneck.
4. Fabricate angle brackets at top and bottom and intermediate brackets where shown. Drill for bolting.

## **2.8 GUARD RAIL/RAILINGS**

### **A. Fabrication:**

1. Fabricate from steel pipe as shown. Provide continuous welded joints, dressed smooth and flush.
2. Standard flush fittings, designed to be welded, may be used.
3. Hot-dip galvanize after fabrication complying with ASTM A123, minimum 355 g/m<sup>2</sup> (1.2 oz/ft<sup>2</sup>) coating thickness.

## **2.9 PIPE BOLLARDS (POST BARRICADES)**

- A. Fabricate pipe bollards from Schedule 80 pipe (4 X-Strong), galvanized pipe; sizes as shown on the Drawings.
- B. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4 inch thick steel plate welded to bottom of sleeve. Make sleeves at least 3/4 inch larger than outer diameter of bollard.
- C. Fixed Post Barricades: Fill-in pipe with concrete grout, top-off and round-off excess concrete as shown on the Drawings.
- D. Removable Post Barricades: Provide steel straps and bolts as shown on the Drawings. Cap top of bollard with flat steel plate welded, with edges eased and rounded smooth.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Set frames of gratings, and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.
- C. Field weld in accordance with AWS.
  1. Design and finish as specified for shop welding.
  2. Use continuous weld unless specified otherwise.
- D. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.

### **3.2      INSTALLATION OF SUPPORTS**

- A. Anchorage to structure.
  - 1. Secure angles or channels and clips to overhead structural steel by continuous welding unless bolting is shown.
  - 2. Secure supports to concrete inserts by bolting or continuous welding as shown.
  - 3. Secure supports to mid height of concrete beams when inserts do not exist with expansion bolts and to slabs, with expansion bolts. unless shown otherwise.
- B. Supports for Wall Mounted items:
  - 1. Locate center of support at anchorage point of supported item.
  - 2. Locate support at top and bottom of wall hung cabinets.
  - 3. Locate support at top of floor cabinets and shelving installed against walls.
  - 4. Locate supports where required for items shown.
- C. Supports for Trapeze Bars:
  - 1. Secure plates to overhead construction with fasteners as shown.
  - 2. Secure angle brace assembly to overhead construction with fasteners as shown and bolt plate to braces.

### **3.3      GRATINGS**

- A. Set grating flush with finish floor; top of curb, or areaway wall.
- B. Set frame in formwork before concrete is placed.
- C. Where grating terminates at a wall bolt frame to concrete with expansion bolts unless shown otherwise.
- D. Secure removable supporting members in place with stainless steel bolts.
- E. Bolt gratings to supports.

### **3.4      LADDERS**

- A. Anchor ladders to walls and floors with expansion bolts through turned lugs or angle clips or brackets.

### **3.5      RAILINGS**

- A. Steel Posts:
  - 1. Secure fixed posts to concrete with expansion bolts through flanged fittings except where sleeves are shown with pourable grout.
  - 2. Install sleeves in concrete formwork.
  - 3. Set post in sleeve and pour grout to surface. Apply beveled bead of

urethane sealant at perimeter of post or under flange fitting as specified in Section 07 92 00, JOINT SEALANTS—on exterior posts.

4. Secure removable posts to concrete with either machine screws through flanged fittings which are secured to inverted flanges embedded in and set flush with finished floor, or set posts in close fitting pipe sleeves without grout.
5. Secure sliding flanged fittings to posts at base with set screws.
6. Secure fixed flanged fittings to concrete with expansion bolts.
7. Secure posts to steel with welds.

B. Anchor to Walls:

1. Anchor rails to substrate securely with machine screws through flanged fitting to steel plate.

C. Gates:

1. Hang gate to swing as shown.

### **3.6 PIPE BOLLARDS (POST BARRICADES)**

- A. Install pipe bollards plumb, level, and aligned with other bollards.
- B. Pipe bollards cast-in-place: Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

### **3.7 CLEAN AND ADJUSTING**

- A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.
- B. Clean after installation exposed prefinished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the project.

### **3.8 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 06 10 00**

**ROUGH CARPENTRY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Section specifies wood blocking, framing, sheathing, furring, nailers, sub-flooring, rough hardware, and light wood construction.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Milled woodwork: Section 06 20 00, FINISH CARPENTRY.
- D. Gypsum sheathing: Section 09 29 00, GYPSUM BOARD.
- E. Cement board sheathing: Section 06 16 63, CEMENTITIOUS SHEATHING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings showing framing connection details, fasteners, connections and dimensions.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Protect lumber and other products from dampness both during and after delivery at site.
- B. Pile lumber in stacks in such manner as to provide air circulation around surfaces of each piece.

- C. Stack plywood and other board products so as to prevent warping.
- D. Locate stacks on well drained areas, supported at least 150 mm (6 inches) above grade and cover with well ventilated sheds having firmly constructed over hanging roof with sufficient end wall to protect lumber from driving rain.

#### **1.5 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.
- B. American Forest and Paper Association (AFPA):
  - 1. National Design Specification for Wood Construction
  - 2. NDS-05 Conventional Wood Frame Construction
- C. American Institute of Timber Construction (AITC):
  - 1. A190.1-07 Structural Glued Laminated Timber
- D. American Society of Mechanical Engineers (ASME):
  - 1. B18.2.1-96(R2005) Square and Hex Bolts and Screws
  - 2. B18.2.2-87 Square and Hex Nuts
  - 3. B18.6.1-97 Wood Screws
  - 4. B18.6.4-98(R2005) Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws
- E. American Plywood Association (APA):
  - 1. E30-07 Engineered Wood Construction Guide
- F. American Society for Testing And Materials (ASTM):
  - 1. A47-99(R2009) Ferritic Malleable Iron Castings
  - 2. A48-03(R2008) Gray Iron Castings
  - 3. A653/A653M-10 Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process
  - 4. C954-10 Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 inch (2.24 mm) to 0.112 inch (2.84 mm) in thickness
  - 5. C1002-07 Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs
  - 6. D143-09 Small Clear Specimens of Timber, Method of Testing
  - 7. D1760-01 Pressure Treatment of Timber Products
  - 8. D2559-10 Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions



- 9. D3498-11 Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
- 10. F844-07 Washers, Steel, Plan (Flat) Unhardened for General Use
- 11. F1667-08 Nails, Spikes, and Staples
- G. Federal Specifications (Fed. Spec.):
  - 1. MM-L-736C Lumber; Hardwood
- H. Commercial Item Description (CID):
  - 1. A-A-55615 Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)
- I. Military Specification (Mil. Spec.):
  - 1. MIL-L-19140E Lumber and Plywood, Fire-Retardant Treated
- J. Truss Plate Institute (TPI):
  - 1. TPI-85 Metal Plate Connected Wood Trusses
- K. U.S. Department of Commerce Product Standard (PS)
  - 1. PS 1-95 Construction and Industrial Plywood
  - 2. PS 20-05 American Softwood Lumber Standard

## **PART 2 - PRODUCTS**

### **2.1 LUMBER:**

- A. Unless otherwise specified, each piece of lumber bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
  - 1. Identifying marks in accordance with rule or standard under which material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification.
  - 2. Inspection agency for lumber approved by the Board of Review, American Lumber Standards Committee, to grade species used.
- B. Lumber Other Than Structural:
  - 1. Unless otherwise specified, species graded under the grading rules of an inspection agency approved by Board of Review, American Lumber Standards Committee.
  - 2. Furring, blocking, nailers and similar items 100 mm (4 inches) and narrower Standard Grade; and, members 150 mm (6 inches) and wider, Number 2 Grade.
- C. Sizes:
  - 1. Conforming to Prod. Std., PS20.

2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.

D. Moisture Content:

1. At time of delivery and maintained at the site.
2. Boards and lumber 50 mm (2 inches) and less in thickness: 19 percent or less.
3. Lumber over 50 mm (2 inches) thick: 25 percent or less.

E. Fire Retardant Treatment:

1. Mil Spec. MIL-L-19140 with piece of treated material bearing identification of testing agency and showing performance rating.
2. Treatment and performance inspection, by an independent and qualified testing agency that establishes performance ratings.

F. Preservative Treatment:

1. Do not treat Heart Redwood and Western Red Cedar.
2. Treat wood members and plywood exposed to weather or in contact with plaster, masonry or concrete, including framing, sole plates, furring, and sleepers that are less than 600 mm (24 inches) from ground; nailers, edge strips, blocking, crickets, curbs, cant, vent strips and other members used in connection with roofing and flashing materials.
3. Preservative treat by the pressure method complying with ASTM D1760, except any process involving the use of Chromated Copper arsenate (CCA) for pressure treating wood is not permitted.

## 2.2 PLYWOOD

A. Comply with Prod. Std., PS 1.

B. Bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of plywood which identifies compliance by veneer grade, group number, span rating where applicable, and glue type.

C. Plywood Backing for Electrical and Telecommunication Room:

1. APA A-C EXT, Douglas Fir with A face exposed; fire-retardant treated (FRT) bearing identification mark indicating flame spread classification (25 or less per ASTM E84) issued by approval agency.
2. Size: 19 mm (3/4 inch) thick.
3. Paint plywood backing per Section 09 91 00, PAINTING. Leave FRT label unpainted.

## **2.3 ROUGH HARDWARE AND ADHESIVES:**

### **A. Anchor Bolts:**

1. ASME B18.2.1 and ANSI B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
2. Extend at least 200 mm (8 inches) into masonry or concrete with ends bent 50 mm (2 inches).

### **B. Miscellaneous Bolts: Expansion Bolts: C1D, A-A-55615; lag bolt, long enough to extend at least 65 mm (2-1/2 inches) into masonry or concrete. Use 13 mm (1/2 inch) bolt unless shown otherwise.**

### **C. Washers:**

1. ASTM F844.
2. Use zinc or cadmium coated steel or cast iron for washers exposed to weather.

### **D. Screws:**

1. Wood to Wood: ANSI B18.6.1 or ASTM C1002.
2. Wood to Steel: ASTM C954, or ASTM C1002.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS:**

#### **A. Fasteners:**

1. Bolts:
  - a. Fit bolt heads and nuts bearing on wood with washers.
  - b. Countersink bolt heads flush with the surface of nailers.
  - c. Embed in concrete or use expansion bolts. Special bolts or screws designed for anchor to solid masonry or concrete in drilled holes may be used.
  - d. Use bolts to steel over 2.84 mm (0.112 inch, 11 gage) in thickness. Secure wood nailers to vertical structural steel members with bolts, placed one at ends of nailer and 600 mm (24 inch) intervals between end bolts. Use clips to beam flanges.
2. Drill Screws to steel less than 2.84 mm (0.112 inch) thick.
  - a. ASTM C1002 for steel less than 0.84 mm (0.033 inch) thick.
  - b. ASTM C 954 for steel over 0.84 mm (0.033 inch) thick.
3. Power actuated drive pins may be used where practical to anchor to concrete, or steel.
4. Do not anchor to wood plugs or nailing blocks in concrete. Use metal plugs, inserts or similar fastening.
5. Screws to Join Wood:
  - a. ASTM C1002, sized to provide not less than 25 mm (1 inch) penetration into anchorage member.

B. Blocking Nailers, and Furring:

1. Install furring, blocking, nailers, and grounds where shown.
2. Use longest lengths practicable.
3. Use fire retardant treated wood blocking where shown at openings and where shown or specified.
4. Layers of Blocking or Plates:
  - a. Stagger end joints between upper and lower pieces.
  - b. Nail at ends and not over 600 mm (24 inches) between ends.
  - c. Stagger nails from side to side of wood member over 125 mm (5 inches) in width.

**3.2 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 06 20 00**

**FINISH CARPENTRY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies counter tops.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Fabricated Metal brackets: Section 05 50 00, METAL FABRICATIONS.
- D. Color and texture of finish: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. Millwork items: Half full size scale for sections and details 1:50 (1/4-inch) for elevations and plans.
  - 2. Show construction and installation.
- C. Samples:
  - 1. Solid surfacing material, 100 mm by 100 mm (4 inches by 4 inches).
- D. Certificates:
  - 1. Indicating moisture content of materials meet the requirements specified.
- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- A. Protect millwork from dampness, maintaining moisture content specified both during and after delivery at site.
- B. Store millwork in weathertight well ventilated structures or in space in existing buildings designated by Resident Engineer. Store at a minimum temperature of 21 deg C (70 deg F) for not less than 10 days before installation.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Testing and Materials (ASTM):
  - 1. D790-10 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  - 2. D2583-07 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
- C. Architectural Woodwork Standards (AWS):
- D. International Solid Surface Fabricators Association (ISSFA)
  - 1. ISSFA SST 4.1 Flatness of Sheets
  - 2. ISSFA SST 6.1 Impact Resistance 226.8g (1/2 lb.) Ball
- E. National Electrical Manufacturers Association (NEMA):
  - 1. LD 3-05 High-Pressure Decorative Laminates
- F. U.S. Department of Commerce, Product Standard (PS):
  - 1. PS20-05 American Softwood Lumber Standard
- G. Federal Specifications (Fed. Spec.):
  - 1. A-A-1922A Shield Expansion
  - 2. FF-N-836D Nut, Square, Hexagon Cap, Slotted, Castle
  - 3. FF-S-111D(1) Screw, Wood

### **PART 2 - PRODUCTS**

#### **2.1 PLYWOOD**

- A. Softwood Plywood:
  - 1. Prod. Std.

2. Grading and Marking:

- a. Each sheet of plywood shall bear the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood.
- b. The mark shall identify the plywood by species group or identification index, and shall show glue type, grade, and compliance with PS1.

B. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.

1. Performance properties required:

Property	Result	Test
Radiant Heat Resistance	600+ seconds, Pass	NEMA LD3-3.10
Flexural Strength	64.75 MPa (9.40 psi)	ASTM D790
Barcol Hardness	65, Pass	ASTM D2583
Flatness of Sheets	Pass	ISSFA SST 4.1
Impact Resistance	Pass	ISSFA SST 6.1

2. Thickness: 12 mm (1/2 inch).

3. Color: As specified in Section 09 06 00.

## 2.2 HARDWARE

A. Rough Hardware:

1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated, or zinc-coated by electric galvanizing process. Galvanized where specified.
2. Fasteners:
  - a. Bolts with Nuts: FF-N-836.
  - b. Expansion Bolts: A-A-1922A.
  - c. Screws: Fed. Spec. FF-S-111.

## 2.3 FABRICATION

A. General:

1. Except as otherwise specified, use AWS Custom Grade for architectural woodwork.
2. Plywood shall be not less than 13 mm (1/2 inch).

**PART 3 - EXECUTION****3.1 ENVIRONMENTAL REQUIREMENTS**

- A. Maintain work areas and storage areas to a minimum temperature of 21 deg C (70 deg F) for not less than 10 days before and during installation of interior millwork.
- B. Do not install finish lumber or millwork in any room or space where wet process systems such as concrete, masonry, or plaster work is not complete and dry.

**3.2 INSTALLATION**

- A. General:
  - 1. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
  - 2. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
  - 3. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
  - 4. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

**3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 13 26**

**SELF-ADHERING SHEET WATERPROOFING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Section Includes:
  - 1. Bonded HDPE sheet waterproofing (Waterproofing Type 1 as indicated on the Drawings).

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Integration and termination with modified bituminous sheet waterproofing (Waterproofing Type 2 as indicated on the Drawings): Section 07 13 52, MODIFIED BITUMINOUS SHEET WATERPROOFING.

**1.3 MANUFACTURER'S QUALIFICATIONS:**

- A. Approval by Contracting Officer is required of products and services of proposed manufacturers, and installers, and will be based upon submission by Contractor that:
  - 1. Manufacturer regularly and presently manufactures bituminous sheet waterproofing as one of its principal products.
  - 2. Installer has technical qualifications, experience, trained personnel and facilities to install specified items.
  - 3. Manufacturer's product submitted has been in satisfactory and efficient operation on three similar installations for at least three years.
  - 4. Submit list of installations, include name and location of project and name of owner.

**1.4 INSTALLER QUALIFICATIONS:**

- A. An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer with a minimum of 5 years successful experience in projects of similar scope.
  - 1. Provide written certification from waterproofing membrane manufacturer that installer is certified by the manufacturer to install the waterproofing system for this application.

### **1.5 QUALITY ASSURANCE**

- A. Provide on-site inspection by waterproofing manufacturer's representative and Resident Engineer of the waterproofing work during construction to provide a method for accepting completed work and to confirm that the work complies with the contract documents.

### **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Bonded HDPE sheet waterproofing.
  - 2. Printed installation instructions for conditions specified.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- E. Certificates:
  - 1. Approval of installer by bonded HDPE sheet waterproofing manufacturers.

### **1.7 PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. Deliver materials to job in manufacturer's original unopened container.
- B. Do not store material in areas where temperature is lower than 10 degrees C (50degrees F,) or where prolonged temperature is above 32 degrees C (90 degrees F).

### **1.8 ENVIRONMENTAL REQUIREMENTS:**

- A. Ambient Surface and Material Temperature: Not less than 4 degrees C (40 degrees F), during application of waterproofing.

**1.9 WARRANTY:**

- A. Work subject to the terms of the Article "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's five year specialty warranty.

**1.10 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced by basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. D412-06ae2 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers Tension
  2. D570-98(2010)e1 Standard Test Method for Water Absorption of Plastics
  3. D903-98(2010) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
  4. D1876-08 Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)
  5. D1970/D1970M-11 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  6. D5385-93(2006) Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes
  7. E96/E96M-10 Standard Test Methods for Water Vapor Transmission of Materials
  8. E154-08a Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

**PART 2 - PRODUCTS**

**2.1 BONDED HDPE SHEET WATERPROOFING**

- A. Bonded HDPE Sheet for Horizontal Applications: Uniform, flexible, multilayered-composite sheet membrane consisting of either an HDPE film coated with pressure-sensitive adhesive and protective release liner, total 46-mil (1.2-mm) thickness; with the following physical properties:
1. Tensile Strength, Film: 2000 psi (13.8 MPa) minimum; ASTM D 412.
  2. Low-Temperature Flexibility: Pass at minus 10 deg F (minus 23 deg C); ASTM D 1970.
  3. Peel Adhesion to Concrete: 5 lbf/in. (875 N/m) minimum; ASTM D 903, modified.
  4. Lap Adhesion: 2.5 lbf/in. (440 N/m) minimum; ASTM D 1876, modified.
  5. Hydrostatic-Head Resistance: 231 feet (70 m); ASTM D 5385, modified.
  6. Puncture Resistance: 200 lbf (890 N) minimum; ASTM E 154.

7. Water Vapor Permeance: 0.01 perms (0.6 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
8. Water Absorption: 0.5 percent maximum; ASTM D 570.

## **2.2 AUXILIARY MATERIALS**

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
- B. Modified Bituminous Detail Tape: Self-adhering detail tape consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; minimum 60-mil (1.5-mm) nominal thickness; 6 inches (150 mm) wide.
- C. Bonded HDPE Detail Tape: Adhesive tape product by bonded HDPE sheet manufacturer; 4 inch wide.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, for compliance with requirements and other conditions affecting performance of the waterproofing.
  1. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

### **3.2 SURFACE PREPARATION**

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

### **3.3 BONDED HDPE SHEET-WATERPROOFING APPLICATION**

- A. Install bonded HDPE sheets according to manufacturer's written instructions.
- B. Horizontal Applications: Install sheet with HDPE or polyethylene face against substrate. Accurately align sheets. Overlap sheets 6 inches (150 mm) minimum. Apply modified bituminous detail tape at back side and bonded HDPE detail tape at front. Stagger end laps to ensure watertight installation..
- C. Apply liquid membrane between cut sheets (non-factory laps). Lap sheets 6 inches (150 mm) minimum.

- D. Seal penetrations through sheet waterproofing to provide watertight seal with detail tape patches or wraps and a liquid-membrane troweling.
- E. Install sheet-waterproofing and auxiliary materials to produce a continuous watertight tie into adjacent waterproofing.
- F. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Tape perimeter of damaged or nonconforming area extending 6 inches (150 mm) beyond repaired areas in all directions. Apply a patch of sheet waterproofing and firmly secure with detail tape.

#### **3.4 PROTECTION, REPAIR, AND CLEANING**

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

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**SECTION 07 13 52**

**MODIFIED BITUMINOUS SHEET WATERPROOFING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies modified bituminous sheet material (Waterproofing Type 2 as indicated on the Drawings) used for exterior below grade waterproofing and split slab waterproofing.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Integration and termination with HDPE bonded sheet waterproofing (Waterproofing Type 1 as indicated on the Drawings): Section 07 13 26, SELF-ADHERING SHEET WATERPROOFING.

**1.3 MANUFACTURER'S QUALIFICATIONS:**

- A. Approval by Contracting Officer is required of products and services of proposed manufacturers, and installers, and will be based upon submission by Contractor that:
  - 1. Manufacturer regularly and presently manufactures bituminous sheet waterproofing as one of its principal products.
  - 2. Installer has technical qualifications, experience, trained personnel and facilities to install specified items.
  - 3. Manufacturer's product submitted has been in satisfactory and efficient operation on three similar installations for at least three years.
  - 4. Submit list of installations, include name and location of project and name of owner.

**1.4 INSTALLER QUALIFICATIONS:**

- A. An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer with a minimum of 5 years successful experience in projects of similar scope.
  - 1. Provide written certification from waterproofing membrane manufacturer that installer is certified by the manufacturer to install the waterproofing system for this application.

### **1.5      QUALITY ASSURANCE**

- A.    Provide on-site inspection by waterproofing manufacturer's representative and Resident Engineer of the waterproofing work during construction to provide a method for accepting completed work and to confirm that the work complies with the contract documents.

### **1.6      SUBMITTALS**

- A.    Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B.    Manufacturer's Literature and Data:
  - 1.    Bituminous sheet.
  - 2.    Primer.
  - 3.    Mastic.
  - 4.    Protection material, temporary and permanent.
  - 5.    Printed installation instructions for conditions specified.
- C.    LEED Submittals:    Submit in accordance with Section 01 81 11.01.
  - 1.    LEED submittals are in addition to other submittals.    If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2.    LEED Product Data Submittal Form:    Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D.    Shop Drawings:    Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- E.    Certificates:
  - 1.    Indicating bituminous sheet manufacturer's approval of primer, and roof cement.
  - 2.    Indicating bituminous sheet waterproofing manufacturer's qualifications as specified.
  - 3.    Approval of installer by bituminous sheet manufacturers.
  - 4.    Water test report.

### **1.7      PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A.    Deliver materials to job in manufacturer's original unopened container.
- B.    Do not store material in areas where temperature is lower than 10 degrees C (50degrees F,) or where prolonged temperature is above 32 degrees C (90 degrees F).



**1.8 ENVIRONMENTAL REQUIREMENTS:**

- A. Ambient Surface and Material Temperature: Not less than 4 degrees C (40 degrees F), during application of waterproofing.

**1.9 WARRANTY:**

- A. Warrant bituminous sheet waterproofing installation against moisture leaks and subject to terms of "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's five-year warranty.

**1.10 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced by basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - 1. UU-B-790A Building Paper, Vegetable Fiber: (Kraft, Water-
  - 2. INT AMD 1 Proof, Water Repellent and Fire Resistant)
- C. American Society for Testing and Materials (ASTM):
  - 1. C578-10 Rigid Cellular Polystyrene Thermal Insulation
  - 2. D41-11 Asphalt Primer Used in Roofing, Dampproofing and Waterproofing
  - 3. D2822-05 Asphalt Roof Cement
  - 4. D6380-03 (R2009) Asphalt Roll Roofing (Organic Felt)
- D. American Hardboard Association (AHA):
  - 1. A135.4-1995 Basic Hardboard

**PART 2 - PRODUCTS**

**2.1 BITUMINOUS SHEET (WATERPROOFING TYPE 2):**

- A. Cold applied waterproofing membrane composed primarily of modified bituminous material prefabricated in sheet form designed for below grade exterior and split slab waterproofing. Sheet reinforced with fibers at manufacturer's option.
- B. Thickness of Bituminous Sheet: 1.5 mm (60 mils), plus or minus 0.13 mm (5 mils), and bonded to a 0.1 mm (4 mil) thick plastic sheet.
- C. Provide with a release sheet to prevent bonding of bituminous sheet to itself.
- D. Physical Properties:
  - 1. Tensile Strength, Membrane: 2.24 MPa (325 psi) minimum; ASTM D 412, Die C, modified.

2. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
3. Low-Temperature Flexibility: Pass at minus 32 deg C (minus 25 deg F); ASTM D 1970.
4. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C 836.
5. Puncture Resistance: 222 N (50 lbf) minimum; ASTM E 154.
6. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 21 deg C (70 deg F); ASTM D 570.
7. Water Vapor Permeance: 2.9 ng/Pa x s x sq. m (0.05 perms) maximum; ASTM E 96/E 96M, Water Method.

## 2.2 **PRIMER:**

- A. Furnished by manufacturer of bituminous sheet as required for particular application in accordance with sheet manufacturer's instructions.
- B. Primer: ASTM D41; Low VOC primer in solvent specially formulated to provide good adhesion of bituminous sheet waterproofing membrane to concrete substrate.
  1. VOC Content: Coatings shall comply with VOC content limits of Bay Area Air Quality Management District (BAAQMD) Regulation 8, Rule 3, Architectural Coatings; and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24); whichever is more stringent:
    - a. VOC Content: Less than 200 g/L.

## 2.3 **PROTECTION MATERIAL:**

- A. Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 100 (0.150-mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a flow rate of 10 to 25 gpm per ft. (125 to 310 L/min. per m).
- B. High-Capacity, Molded-Sheet Collector-Panel System: Composite subsurface collector-panel system by same manufacturer as primary molded-sheet drainage panels; consisting of a high-profile, studded, nonbiodegradable, molded-plastic-sheet drainage core; with a geotextile facing with an apparent opening size not exceeding No. 100 (0.150-mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a flow rate of 16 to 100 gpm per ft. (200 to 1250 L/min. per m). Provide system with manufacturer's outlets, connectors, tapes, and other accessories to connect primary molded-sheet drainage panels with storm drainage system specified in Section 334000 - STORM DRAINAGE UTILITIES.

## 2.4 **AUXILIARY MATERIALS**

- A. General: Furnish auxiliary materials recommended by waterproofing

manufacturer for intended use and compatible with sheet waterproofing.

- B. Mastic: Rubberized asphalt-based mastic by sheet waterproofing material manufacturer.
- C. Metal Termination Bars: Aluminum bars, approximately 25 by 3 mm (1 by 1/8 inch) thick, predrilled at 229-mm (9-inch) centers.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION:**

- A. Surface Condition:
  - 1. Before applying waterproofing materials, ensure concrete and masonry surfaces are fully cured, smooth, clean, dry, and free from high spots, depressions, loose and foreign particles and other deterrents to adhesion.
  - 2. Fill voids, joints, and cracks with patching compound.
- B. Concrete surfaces cured a minimum of seven days, free from release agents, concrete curing agents, and other contaminants.

#### **3.2 APPLICATION:**

- A. Priming:
  - 1. Prime concrete surfaces.
  - 2. Application method, amount of primer and condition or primer before installation of bituminous sheet as recommended by primer manufacturer.
  - 3. Reprime when required in accordance with manufacturer's instructions.
- B. Bituminous Sheet Installation:
  - 1. Remove release sheet prior to application.
  - 2. Lay bituminous sheet from low point to high point so that laps shed water.
  - 3. Treat expansion, construction and control joints and evident working cracks as expansion joints. Apply bituminous sheet in double thickness over joint by first applying a strip of bituminous sheet not less than 200 mm (8 inches) wide, centered over joint.
  - 4. Lap seams not less than 150 mm (6 inches).
  - 5. Lay succeeding sheet with laps, and hand roll with a roller.
  - 6. Repair misaligned or inadequately lapped seams in accordance with manufacturer's instructions.
  - 7. Seal seams and terminations in accordance with sheet manufacturer's instructions. Treat all seams, laps, and edges with 6 mm by 25 mm (1/4 inch by 1 inch) troweling of liquid membrane.

C. Corner Treatment:

1. At inside and outside corners apply double cover using an initial strip not less than 300 mm (12 inches) wide, centered along axis of corner.
2. Cover each strip completely by the regular application of bituminous sheet.
3. Provide a fillet or cant on inside corners.
4. Form cants using patching compound
  - a. Do not use wood, fiber, and insulating materials for cants.

D. Top Edge Treatment:

1. Provide a termination bar at the top edge of the membrane coated with liquid membrane.
2. Integrate the top edge of the membrane with the wall resistive barrier system to provide continuity from below-grade to above-grade. Provide a stainless steel counter flashing where waterproof membrane is exposed at grade.

E. Projection Treatment:

1. Apply a double layer of bituminous sheet around pipes and similar projections at least 150 mm (6 inches) wide.
2. At drains, apply a bead of roof cement over a double layer of bituminous sheet under clamping rings.

**3.3 PROTECTION:**

- A. Protect bituminous sheet before backfill or wearing courses are placed.
- B. Install protection material and hold in place in accordance with instructions of manufacturer of waterproofing materials.
- C. Temporary Protection:
  1. When waterproofing materials are subjected to damage by sunlight and can not be immediately protected as specified, protect waterproofing materials by waterproof building paper or suitable coating approved by manufacturer of waterproofing system used.

**3.4 PATCHING:**

- A. Repair tears, punctures, air blisters, and inadequately lapped seams, in accordance with manufacturer's instructions before protection course is applied.

**3.5 INSPECTION:**

- A. Do not cover waterproofed surfaces by other materials or backfill until work is approved by Resident Engineer.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 19 00**

**WATER REPELLENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section includes silicone-emulsion water-repellent treatments for the following vertical surfaces:
  - 1. Tilt-up concrete.

**1.2 PERFORMANCE REQUIREMENTS**

- A. General Performance: Water repellents shall meet performance requirements indicated without failure due to defective manufacture, fabrication, or installation.
  - 1. Water Repellents: Comply with performance requirements specified, as determined by preconstruction testing substrate assemblies representing those indicated for this Project.
- B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours in comparison of treated and untreated specimens, when tested per ASTM C642.
- C. Durability: Maximum 5 percent loss of water-repellent properties after 2500 hours of weathering according to ASTM G154 in comparison to water-repellent-treated specimens before weathering.

**1.3 PRECONSTRUCTION TESTING**

- A. Preconstruction Testing: Installed water repellents shall comply with performance requirements indicated, as evidenced by reports based on Project-specific preconstruction testing of existing substrate assemblies by a qualified testing agency.
  - 1. Select sizes and configurations of assemblies to adequately demonstrate capability of water repellents to comply with performance requirements.
  - 2. In addition to verifying performance requirements, use test applications to verify manufacturer's written instructions for application procedure and optimum rates of product application to substrate assemblies.
  - 3. Notify Resident Engineer seven days in advance of the dates and times when assemblies will be tested.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Product Data: For each type of product indicated.
  - 1. Include manufacturer's printed statement of VOC content.
  - 2. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Preconstruction Testing Reports: For water-repellent-treated substrates.
- E. Field quality-control reports.
- F. Warranty: Special warranty specified in this Section.

#### **1.5 QUALITY ASSURANCE**

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. Mockups: Apply water repellent to each type of substrate required.
  - 1. Locate each test application as directed by Resident Engineer.
  - 2. Size: 25 sq. ft. (2.3 sq. m).
- C. Preinstallation Conference: Conduct conference at Project site.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. C642-06 Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
  - 2. G154-06 Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- C. Master Painters Institute (MPI):
  - 1. MPI Approved Products List - 2012.
  - 2. MPI Performance Standards



## **1.7 PROJECT CONDITIONS**

- A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
1. Concrete surfaces and mortar have cured for not less than 28 days.
  2. Building has been closed in for not less than 30 days before treating wall assemblies.
  3. Ambient temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C) and will remain so for 24 hours.
  4. Substrate is not frozen and substrate-surface temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C).
  5. Rain or snow is not predicted within 24 hours.
  6. Not less than **24 hours** have passed since surfaces were last wet.
  7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

## **1.8 WARRANTY**

- A. Work subject to the terms of the Article "Warranty of Construction," FAR clause 52.246-21. Provide manufacturer's special warranty as follows:
1. Special Warranty: Manufacturer's standard form in which manufacturer agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.
    - a. Warranty Period: Five years.

## **PART 2 - PRODUCTS**

### **2.1 WATER REPELLENTS AND GRAFFITI-RESISTANT COATING**

- A. Water Repellent and Graffiti-Resistant Coating: Penetrating, silicone type, clear, non-yellowing, and breathable; compatible with manufacturer's graffiti-removal treatment product; applied by brush, flooding, spray, or roller.
1. VOC Content: Less than 100 g/L.
  2. Reference Standard: Products that are approved and listed in Master Painters Institute's MPI Approved Product List, MPI #117; or products accepted by the Resident Engineer to meet MPI #117 after submitting certification and test results that water repellent product meets MPI #117.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
  - 1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
  - 2. Inspect for previously applied treatments that may inhibit penetration or performance of water repellents.
  - 3. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
  - 4. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Test pH level according to water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions and as follows:
  - 1. Cast-in-Place Concrete: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents.
- B. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.
- C. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
  - 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

#### **3.3 APPLICATION**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water

repellent and to instruct Applicator on the product and application method to be used, and to ensure that manufacturer's warranty requirements are done.

- B. Apply a heavy-saturation coating of water repellent, on surfaces indicated for treatment, using 15 psi- (103 kPa-) pressure spray with a fan-type spray nozzle, roller, or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
- C. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

### **3.4 FIELD QUALITY CONTROL**

- A. Testing of Water-Repellent Material: Government reserves the right to invoke the following procedure at any time and as often as Government deems necessary during the period when water repellent is being applied:
  - 1. Government will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
  - 2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
  - 3. Government may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor shall remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Resident Engineer.
- B. Coverage Test: In the presence of Resident Engineer, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
  - 1. Notify Resident Engineer seven days in advance of the dates and times when surfaces will be tested.
  - 2. Reapply water repellent until coverage test indicates complete coverage.

### **3.5 CLEANING**

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Resident Engineer.
- B. Comply with manufacturer's written cleaning instructions.

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**SECTION 07 21 13**

**THERMAL INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies acoustical insulation for buildings.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Insulation in connection with roofing and waterproofing: Section 07 22 00, ROOF AND DECK INSULATION.
- D. Safing insulation: Section 07 84 00, FIRESTOPPING.

**1.3 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES .
- B. Manufacturer's Literature and Data:
  - 1. Insulation, each type used
  - 2. Adhesive, each type used.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 STORAGE AND HANDLING:**

- A. Store insulation materials in weathertight enclosure.
- B. Protect insulation from damage from handling, weather and construction operations before, during, and after installation.

## **1.5 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. C270-08 Mortar for Unit Masonry
  2. C516-08 Vermiculite Loose Fill Thermal Insulation
  3. C549-06 Perlite Loose Fill Insulation
  4. C552-07 Cellular Glass Thermal Insulation.
  5. C553-08 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
  6. C578-08 Rigid, Cellular Polystyrene Thermal Insulation
  7. C591-08 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
  8. C612-04 Mineral Fiber Block and Board Thermal Insulation
  9. C665-06 Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
  10. C728-05 Perlite Thermal Insulation Board
  11. C954-07 Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Base to Steel Studs From 0.033 (0.84 mm) inch 0.112 inch (2.84 mm) in thickness
  12. C1002-07 Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
  13. D312-00 (R2006) Asphalt Used in Roofing
  14. E84-08 Surface Burning Characteristics of Building Materials
  15. F1667-05 Driven Fasteners: Nails, Spikes and Staples.

## **PART 2 - PRODUCTS**

### **2.1 INSULATION - GENERAL:**

- A. Insulation Products shall comply with following minimum content standards for recovered materials:

Material Type	Percent by Weight
Glass fiber reinforced	6 percent recovered material

The minimum-content standards are based on the weight (not the volume) of the material in the insulating core only.

**2.2 ACOUSTICAL INSULATION:**

- A. Mineral Fiber Batt or Blankets: ASTM C665. Maximum flame spread of 25 and smoke development of 450 when tested in accordance with ASTM E84.
  - 1. Thickness as shown; of widths and lengths to fit tight against framing.

**2.3 FASTENERS:**

- A. Impaling Pins: Steel pins with head not less than 50 mm (2 inches) in diameter with adhesive for anchorage to substrate. Provide impaling pins of length to extend beyond insulation and retain cap washer when washer is placed on the pin.

**2.4 ADHESIVE:**

- A. As recommended by the manufacturer of the insulation.

**PART 3 - EXECUTION**

**3.1 INSTALLATION - GENERAL**

- A. Install rigid insulating units with joints close and flush, in regular courses and with cross joints broken.
- B. Install batt or blanket insulation with tight joints and filling framing void completely. Seal cuts, tears, and unlapped joints with tape.
- C. Fit insulation tight against adjoining construction and penetrations, unless specified otherwise.

**3.2 RIGID INSULATION ON SURFACE OF EXTERIOR WALLS, FLOORS, AND UNDERSIDE OF FLOORS:**

- A. On the interior face of solid masonry and concrete walls, beams, beam soffits, underside of floors, and to the face of studs for interior wall finish where shown.
- B. Bond to solid vertical surfaces with adhesive as recommended by insulation manufacturer. Fill joints with adhesive cement.
- C. Use impaling pins for attachment to underside of horizontal surfaces. Space fastenings as required to hold insulation in place and prevent sagging.

**3.3 ACOUSTICAL INSULATION:**

- A. Fasten blanket insulation between metal studs and wall furring with continuous pressure sensitive tape along edges or adhesive.
- B. Pack insulation around door frames and windows and in cracks, expansion joints, control joints, door soffits and other voids. Pack behind outlets,

around pipes, ducts, and services encased in wall or partition. Hold insulation in place with pressure sensitive tape or adhesive.

- C. Do not compress insulation below required thickness except where embedded items prevent required thickness.
- D. Where acoustical insulation is installed above suspended ceilings install blanket at right angles to the main runners or framing. Extend insulation over wall insulation systems not extending to structure above.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 22 00**

**ROOF AND DECK INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof and deck insulation, vapor retarder, and cover board on new construction ready to receive roofing or waterproofing membrane.
- B. Repairs and alteration work to existing roof insulation.

**1.2 RELATED WORK**

- A. General sustainable design documentation requirements: Section 01 81 13.01 SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Wood blocking, and edge strips: Section 06 10 00, ROUGH CARPENTRY.
- D. Sheet metal components and wind uplift requirements for roof-edge design: Section 07 60 00, FLASHING AND SHEET METAL.

**1.3 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. American Society of Heating, Refrigeration and Air Conditioning (ASHRAE):
  - 1. 90.1-07 Energy Standard for Buildings Except Low-Rise Residential Buildings
- C. ASTM International (ASTM):
  - 1. C208-08 Cellulosic Fiber Insulating Board
  - 2. C552-07 Cellular Glass Thermal Insulation
  - 3. C726-05 Mineral Fiber Roof Insulation Board
  - 4. C728-05 Perlite Thermal Insulation Board
  - 5. C1177/C1177M-08 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
  - 6. C1278/C1278M-07 Standard Specification for Fiber-Reinforced Gypsum Panel
  - 7. C1289-10 Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

8. C1396/C1396M-09 Standard Specification for Gypsum Board
  9. D41-05 Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
  10. D312-06 Asphalt Used in Roofing
  11. D1970-09 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  12. D2178-04 Asphalt Glass Felt Used in Roofing and Waterproofing
  13. D2822-05 Asphalt Roof Cement
  14. D4586-07 Standard Specification for Asphalt Roof Cement, Asbestos-Free
  15. E84-09 Standard Test Method for Surface Burning Characteristics of Building Material
  16. F1667-05 Driven Fasteners: Nails, Spikes, and Staples
- D. FM Approvals: RoofNav Approved Roofing Assemblies and Products.
1. 4450-89 Approved Standard for Class 1 Insulated Steel Deck Roofs
  2. 4470-10 Approved Standard for Class 1 Roof Coverings
  3. 1-28-09 Loss Prevention Data Sheet: Design Wind Loads.
  4. 1-29-09 Loss Prevention Data Sheet: Above-Deck Roof Components
  5. 1-49-09 Loss Prevention Data Sheet: Perimeter Flashing
- E. National Roofing Contractors Association: Roofing and Waterproofing Manual
- F. U.S. Department of Agriculture (USDA): USDA BioPreferred Catalog, [www.biopreferred.gov](http://www.biopreferred.gov)
- G. Underwriters Laboratories, Inc. (UL): Fire Resistance Directory (2009)
- H. U.S. Department of Commerce National Institute of Standards and Technology (NIST):
1. DOC PS 1-09 U.S. Product Standard for Construction and Industrial Plywood
  2. DOC PS 2-04 Performance Standard for Wood-Based Structural-Use Panels.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Thermal Performance: Provide roof insulation meeting minimum overall average R-value of 33, with minimum R-value at any location of 10.
- B. FM Approvals: Provide roof insulation complying with requirements in FM Approvals 4450 and 4470 as part of specified roofing system, listed in FM Approvals "RoofNav" as part of roofing system meeting Fire/Windstorm Classification in Division 07 roofing section.

## **1.5 QUALITY CONTROL**

- A. Requirements of Division 07 roofing section for qualifications of roofing system insulation Installer; Work of this Section shall be performed by same Installer.
- B. Requirements of Division 07 roofing section for inspection of Work of this Section and qualifications of Inspector.
- C. Unless specified otherwise, comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to insulation for storage, handling, and application.
- D. Requirements of roofing system uplift pressure design for specified roofing system.
- E. Requirements of applicable FM Approval for specified roofing system insulation attachment.
- F. Requirements of applicable Miami-Dade County approval for high-wind zone design.

## **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data:
  - 1. Adhesive materials, each type.
  - 2. Roofing cement, each type.
  - 3. Roof insulation, each type.
  - 4. Cover board, each type.
  - 5. Fastening requirements.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
  - 3. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
  - 4. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

- D. Shop Drawings: Include plans, sections, details, and attachments.
  - 1. Nailers, cants, and terminations.
  - 2. Layout of insulation showing slopes, tapers, penetration, and edge conditions.
- E. Samples:
  - 1. Roof insulation, each type.
  - 2. Nails and fasteners, each type.
- F. Certificates:
  - 1. Indicating type, thermal conductance, and minimum and average thickness of insulation.
  - 2. Indicating materials and method of application of insulation system meet the requirements of FM Approvals for specified roofing system.
- G. Laboratory Test Reports: Thermal values of insulation products.
- H. Layout of tapered roof system showing units required.
- I. Documentation of supervisors' and inspectors' qualifications.

#### **1.7 DELIVERY, STORAGE AND MARKING**

- A. Comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to built-up roofing for storage, handling and installation requirements.

#### **1.8 QUALITY ASSURANCE:**

- A. Product/Material Requirements: Obtain products of this section (roof insulation, cover, board, vapor retarder, adhesives, and other component accessories) with roofing system specified in Section 07 52 16.13, STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE ROOFING, COLD-APPLIED, from a single manufacturer or from sources recommended by roofing system manufacturer and incorporated in manufacturer's warranty.
- B. Roof insulation on combustible or steel decks shall have a flame spread rating not greater than 75 and a smoke developed rating not greater than 150, exclusive of covering, when tested in accordance with ASTM E84, or shall have successfully passed FM Approvals 4450.
  - 1. Insulation bearing the UL label and listed in the UL Building Materials Directory as meeting the flame spread and smoke developed ratings will be accepted in-lieu-of copies of test reports.
  - 2. Compliance with flame spread and smoke developed ratings will not be required when insulation has been tested as part of a roof construction assembly of the particular type used for this project and the construction is listed as fire-classified in the UL Building Materials Directory or listed as Class I roof deck construction in the FM Approvals "RoofNav."

3. Insulation tested as part of a roof construction assembly shall bear UL or FM labels attesting to the ratings specified herein.

## **PART 2 - PRODUCTS**

### **2.1 ADHESIVE MATERIALS**

- A. Adhesive Materials, General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use, identical to materials utilized in approved listed roofing system, and compatible with roofing membrane.
  1. Liquid-type adhesive materials shall comply with VOC limits of the Bay Area Air Quality Management District (BAAQMD).
  2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Multipurpose Construction Adhesives: 70 g/L.
    - b. Other Adhesives: 250 g/L.
- B. Bead-Applied Urethane Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one- or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.

### **2.2 ROOF AND DECK INSULATION**

- A. Roof and Deck Insulation, General: Preformed roof insulation boards approved by roofing manufacturer and listed as component of FM Approvals-approved roofing system.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, glass-fiber mat facer on both major surfaces.
- C. Tapered Roof Insulation System:
  1. Fabricate of mineral fiberboard, polyisocyanurate, perlite board, or cellular glass. Use only one insulation material for tapered sections. Use only factory-tapered insulation.
  2. Cut to provide high and low points with crickets and slopes as shown.
  3. Minimum thickness of tapered sections; 38 mm (1-1/2 inch).
  4. Minimum slope 1:48 (1/4 inch per 12 inches).

### **2.3 INSULATION ACCESSORIES**

- A. Cants and Tapered Edge Strips:
- B. Insulation Cant Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board

C. Vapor Retarder:

1. Self-Adhering Sheet Vapor Retarder: ASTM D1970, minimum of 1.0-mm- (40-mil-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive, or 0.76- to 1.0-mm- (30- to 40-mil-) thick, polyethylene film laminated to layer of butyl rubber adhesive; maximum permeance rating of 6 ng/Pa x s x sq. m (0.1 perm).
  - a. Provide manufacturer's recommended primer.

D. Cover Board:

1. Glass-mat, water-resistant gypsum substrate, ASTM C1177/C1177M, 13 mm (1/2 inch) thick, factory primed.

**2.4 FASTENERS**

- A. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with FM Approvals 4470, designed for fastening substrate board to roof deck.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Comply with requirements of Division 07 roofing section.

**3.2 PREPARATION**

- A. Comply with requirements of Division 07 roofing section.

**3.3 SUBSTRATE BOARD INSTALLATION**

- A. Fasten substrate board to top flanges of steel deck to resist uplift pressures according to roofing system manufacturer's instructions and requirements of FM Approvals listing for specified roofing system.

**3.4 VAPOR RETARDER INSTALLATION**

A. General:

1. Install continuous vapor retarder on roof decks where indicated.
2. At vertical surfaces, turn up vapor retarder to top of insulation or base flashing.
3. At all pipes, walls, and similar penetrations through vapor retarder, seal openings with roof cement to prevent moisture entry from below.
4. Seal penetrations with roof cement.

B. Cast in Place Concrete Decks:

1. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum

of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling.

### **3.5 RIGID INSULATION INSTALLATION**

#### **A. Insulation Installation, General:**

1. Install roof insulation in accordance with roofing system manufacturer's written instructions.
2. Install roof insulation in accordance with requirements of FM Approval's Listing for specified roofing system.
3. Cant Strips: Install preformed insulation cant strips at junctures of roofing system with vertical construction.

#### **B. Insulation Thickness:**

1. Thickness of roof insulation shown on drawings is nominal. Actual thickness shall provide the average thermal resistance "R" value of not less than that specified in Performance Requirements Article.
2. Use not less than two layers of insulation when insulation is 68 mm (2.7 inch) or more in thickness unless specified otherwise. Stagger joints minimum 150 mm (6 inches).

#### **C. Lay insulating units with close joints, in regular courses and with cross joints broken. When laid in more than one layer, break joints of succeeding layers of roof insulation with those in preceding layer.**

#### **D. Lay units with long dimension perpendicular to the rolled (longitudinal) direction of the roofing felt.**

#### **E. Seal all cut edges at penetrations and at edges against blocking with bitumen or roof cement.**

#### **F. Cut to fit tight against blocking or penetrations.**

#### **G. Cover all insulation installed on the same day; comply with temporary protection requirements of Division 07 roofing section.**

#### **H. Installation Method:**

1. Adhered Insulation:
  - a. Set each layer of insulation firmly in ribbons of bead-applied insulation adhesive.
2. Cover Board: Install cover boards over insulation with long joints in continuous straight lines with staggered end joints. Offset cover board joints from insulation joints minimum 150 mm (6 inches). Fasten cover boards according to "Adhered Insulation" requirements.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

#### **A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.**

- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 26 13.13**

**CONCRETE SLAB APPLIED VAPOR RETARDER**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section includes water vapor retarders applied on concrete floor slab scheduled to receive floor finishes, which do not meet the water vapor emission limits specified.
- B. Contractor's Responsibility: Suitability of concrete slab to meet vapor emission limits as required by scheduled floor finish materials is the responsibility of the Contractor. Where concrete slab exceeds vapor emission limits, apply topical vapor retarders specified in this section.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 033000 "Cast-in-Place Concrete" for concrete floor slab.
- D. Section 096516 "Resilient Sheet Flooring" for concrete floor slab water vapor emission limits for resilient sheet flooring.
- E. Section 096516.13 "Linoleum Flooring" for concrete floor slab water vapor emission limits for linoleum flooring.
- F. Section 096519 "Resilient Tile Flooring" for concrete floor slab water vapor emission limits for resilient tile flooring.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: Include product performance characteristics, test reports, and application instructions.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by

vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Applicator.
- B. Product Test Reports: For applied vapor retarder, for tests performed by a qualified testing agency acceptable to the Architect.
  - 1. ASTM E 96/96 M, *Standard Test Methods for Water Vapor Transmission of Materials*, Water Method.
  - 2. ASTM D 1308, *Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes*; minimum 14 days.
  - 3. ASTM D 4541, *Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*.
  - 4. ASTM D 7234, *Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers*.
- C. Field quality-control reports.
- D. Certifications: Furnish written certification that the manufacturer has verified the compatibility between the vapor retarder provided and the flooring product scheduled to be applied, including adhesives and floor leveling materials.

#### **1.5 QUALITY ASSURANCE**

- A. Applicator Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Preinstallation Conference: Conduct conference at Project site.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver liquid materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by manufacturer.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Protect stored materials from direct sunlight.

#### **1.7 WARRANTY**

- A. Work subject to the terms of the Article "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's specialty warranty as follows:

- B. Manufacturer's Special Warranty: Manufacturer and Installer agree to repair or replace the applied concrete vapor retarder, the new floor covering or coating, including materials and labor for applied concrete vapor retarder that fails to remain adhered to the substrate or is affected by moisture or alkalinity within the specified warranty period. Manufacturer's warranty requires manufacturer's inspection and written authorization, prior to removal of existing floor covering and applied concrete vapor retarder.

1. Warranty Period: 10 years.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS, GENERAL**

- A. Compatibility: Provide vapor retarders that are compatible with adhesives and floor covering scheduled to be applied on top of the vapor retarder, and with floor leveling products required for flooring installation, as demonstrated by vapor retarder manufacturer, based on testing and field experience.
- B. VOC Content: Products shall comply with VOC limits of Bay Area Air Quality Management District (BAAQMD), Reg. 8, Rule 3, effective 01/01/2011 and LEED-NC, whichever is more stringent, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Sealers: 100 g/L.

### **2.2 VAPOR RETARDERS**

- A. Performance Requirements:
1. Permeance: Maximum 0.3 perms (0.209 g/h·m<sup>2</sup>), when tested in accordance with ASTM E 96 (water method).
  2. Alkalinity Resistance: Unaffected by a pH of 14 when tested in accordance with ASTM D 1308, minimum 14 days.
  3. May be installed on concrete with moisture vapor emission rates of up to 20 lbs of water per 1000 sq. ft. in 24 hours (334 ng/Pa·s·m<sup>2</sup>), when tested in accordance with ASTM F 1869, anhydrous calcium chloride test; and up to 95% relative humidity when tested in accordance with ASTM F 2170, in situ hygrometer probe test.
  4. Adhesion to concrete: 500 psi (3,450 KPa) or greater, as tested in accordance with ASTM D 4541 or ASTM D 7234.

### **2.3 RELATED MATERIALS**

- A. Primers and Cement Topcoat: Where primers and cement topcoats are necessary for floor finishing installation, use primer and cement-based underlayment products recommended by vapor retarder manufacturer.
- B. Concrete Testing Equipment: Subject to compliance with requirements, provide the following products by American Moisture Test, Inc.:
1. Calcium Chloride Moisture Test Kit for ASTM F 1869.

2. In-Situ Relative Humidity Meter and Probe for ASTM F 2170.
3. Digital Ph Meter for ASTM F 2170.
4. Infrared surface temperature meter.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Water Vapor Emission Testing:
  1. Perform pre-installation testing of the concrete slab prior to the application of applied vapor retarder. Testing shall be performed by a qualified testing personnel and testing laboratory.
  2. Condition the area to be tested for at least 48 hours prior to testing to allow the concrete slab to reach equilibrium with the building's ambient conditions at the service temperature and humidity expected during normal operation. Maintain the temperature and relative humidity for the duration of the testing.
- B. Perform three tests for the first 1000 sq. ft. (92.9 m2) of flooring. Add one test for each additional 1000 sq. ft. (92.9 m2) or fraction thereof. Conduct tests around the perimeters of the room, at columns, and where moisture may be evident.
  1. Moisture:
    - a. Perform ASTM F 1869 anhydrous calcium chloride testing on clean concrete slabs when required by flooring finish manufacturer; free of curing, sealing, adhesive residue, water and surface contaminates in an area 20 inches by 20 inches (508 mm by 508 mm), 24-hours before test kits are installed.
    - b. Perform ASTM F 2170 in situ hygrometer probe test at depth of 40% slab thickness for concrete slab that is allowed to dry from top only, and at depth of 20% of slab thickness for concrete slab that is allowed to dry from top and bottom.
  2. Alkalinity: Perform ASTM F 710 alkalinity testing during retrieval of moisture tests, directly inside dome area by placing several drops of manufacturer provided solution to concrete surface. Wait 60-seconds and apply digital LCD pH meter. Record results to the nearest hundredth on final test report.
  3. Temperature, Humidity and Surface Thermometer: Document temperature, humidity and surface temperature before testing at installation of kits or probe sleeves, and on final testing report.
  4. Infrared Surface Thermometer: Document concrete surface temperature at start of testing and at end of testing. Provide results on testing report.
  5. Record on finish floor plans the number and location of tests conducted on concrete surface.

### **3.2 SURFACE PREPARATION**

- A. Concrete surfaces to be tested shall be clean and free of residue, debris, and sealing compounds.
- B. Shot blast concrete surfaces to International Concrete Repair Institute (ICRI) Concrete Surface Profile (CSP) 3 to 4.
- C. Diamond-grind concrete surface near wall base, edges, and corners.
- D. Sweep and vacuum clean substrates as required, immediately before application of vapor retarder.

### **3.3 APPLICATION**

- A. Apply vapor retarder by squeegee, spray, and/or roller method to saturate the concrete surface. Apply materials in accordance with manufacturer's instructions.
- B. Coverage rates shall be in accordance with manufacturer's recommendations based on concrete density and porosity.
- C. Allow materials to penetrate and cure. Re-test substrate and re-apply vapor retarder if areas exceed the following:
  - 1. ASTM F 1869 (as modified to exclude removal of surface finish): Water vapor emission not to exceed 3.0 lb of water/1000 sq. ft. (50 ng/Pa·s·m<sup>2</sup>) in 24 hours.
  - 2. ASTM F 710: No reaction to up to 9.0 pH alkali solution.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 52 16.13**

**STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE ROOFING, COLD-APPLIED**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies modified bituminous sheet roofing and base flashing installed using cold-applied adhesive on new construction with solar reflective granular coating.
- B. Repairs and alteration work, including temporary roofs.

**1.2 RELATED WORK**

- A. General sustainable design documentation requirements: Section 01 81 13.01 SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Roof Insulation under Membrane: Section 07 22 00, ROOF AND DECK INSULATION.
- D. Vapor barrier: Section 07 22 00, ROOF AND DECK INSULATION.
- E. Sheet metal components and wind uplift requirements for roof-edge design: Section 07 60 00, FLASHING AND SHEET METAL.
- F. Miscellaneous items: Section 07 71 00, ROOF SPECIALTIES.

**1.3 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):
  - 1. ANSI/SPRI ES-1-03 Wind Design Standards for Edge Systems Used with Low Slope Roofing Systems
- C. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
  - 1. ASCE/SEI-7-10 Minimum Design Loads for Buildings and Other Structures
- D. Asphalt Roofing Manufacturers Association/National Roofing Contractors Association (ARMA/NRCA): Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing

E. ASTM International (ASTM):

1. C1370-00(R2005) Standard Test Method for Determining the Chemical Resistance of Aggregates for Use in Chemical-Resistant Sulfur Polymer Cement Concrete and Other Chemical-Resistant Polymer Concretes
2. C1371-04 Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
3. C1549-04 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
4. D146-04 Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
5. D1644-01(R2006) Standard Test Methods for Nonvolatile Content of Varnishes
6. D2523-00(R2006) Standard Practice for Testing Load-Strain Properties of Roofing Membranes
7. D2823-05 Standard Specification for Asphalt Roof Coatings, Asbestos Containing
8. D3960-05 Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
9. D4073-06 Standard Test Method for Tensile-Tear Strength of Bituminous Roofing Membranes
10. D4263-83(2005) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
11. D4586-07 Asphalt Roof Cement, Asbestos Free
12. D4601-04 Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
13. D4897-01 Asphalt Coated Glass Fiber Venting Base Sheet Used in Roofing
14. D5147-07 Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
15. D5201-05(R2010) Standard Practice for Calculating Formulation Physical Constants of Paints and Coatings
16. D6162-00(R2008) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
17. D6163-00(2008) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
18. D6164-05 Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
19. D6511-06 Standard Test Methods for Solvent Bearing Bituminous Compounds



- 20. E108-10 Standard Test Methods for Fire Tests of Roof Coverings
- 21. E408-71 (R2008) Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
- 22. E1918-06 Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
- 23. E1980-01 Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
- 24. WK 29032-10 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
- F. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
  - 1. ASHRAE 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings, Appendix f.
- G. Bay Area Air Quality Management District:
  - 1. Reg. 8, Rule 3 Architectural Coatings.
  - 2. Reg. 8, Rule 51 Adhesive and Sealant Products.
- H. Cool Roof Rating Council:
  - 1. CRRC-1 Product Rating Program, [www.coolroofs.org](http://www.coolroofs.org)
- I. FM Approvals: RoofNav Approved Roofing Assemblies and Products.
  - 1. 4450 Approved Standard for Class 1 Insulated Steel Deck Roofs
  - 2. 4470 Approved Standard for Class 1 Roof Coverings
  - 3. 1-28 Loss Prevention Data Sheet: Design Wind Loads.
  - 4. 1-49 Loss Prevention Data Sheet: Perimeter Flashing
- J. National Roofing Contractors Association: Roofing and Waterproofing Manual
- K. U.S. Environmental Protection Agency (EPA):
  - 1. EPA 600/R13/116 Method for the Determination of Asbestos in Bulk Building Materials
- L. U.S. Department of Agriculture (USDA): USDA BioPreferred Catalog, [www.biopreferred.gov](http://www.biopreferred.gov)
- M. U.S. Department of Energy (DoE): Roof Products Qualified Product List, [www.energystar.gov](http://www.energystar.gov)

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

- B. Roofing Membrane System Load-Strain Properties: Provide a roofing membrane identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when tested according to ASTM D2523:
  - 1. Tensile strain at failure, at 0 deg F (-18 deg C): 600 lbf (2.67 kN) cross machine direction, minimum; 4.0 to 5.5 percent elongation at break.
- C. Roofing System Energy Performance Requirements: Provide a roofing system identical to components that that have been successfully tested by a qualified independent testing and inspecting agency to meet the following requirements:
  - 1. Energy Performance, Energy Star: Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
  - 2. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.
  - 3. Energy Performance, Aged: Provide roofing system with minimum three-year aged solar reflectance not less than 0.55 when tested in accordance with ASTM C1549 or ASTM E1918, and in addition, a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408.
    - a. Where tested aged values are not available for proposed product, submit calculations to adjust initial solar reflectance to demonstrate compliance as indicated in ASHRAE 90.1-2007 Addendum f.
    - b. Alternatively, provide roofing system with minimum three-year aged Solar Reflectance Index of not less than 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 BTU/h-ft<sup>2</sup> (12 W/m<sup>2</sup>K).

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Licensed or approved in writing by manufacturer to perform work under warranty requirements of this Section.
  - 2. Employ full-time supervisors knowledgeable and experienced in roofing of similar types and scopes, and able to communicate with owner and workers.
- B. Inspector Qualifications: Inspection of work by third-party technical inspector or technical representative of manufacturer experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
  - 1. An authorized full-time technical employee of the manufacturer, not engaged in the sale of products.

2. An independent party certified as a Registered Roof Observer by the Roof Consultants Institute (RCI), retained by the Contractor or the Manufacturer and approved by the Manufacturer.
- C. Product/Material Qualifications:
1. Obtain roofing system specified in this section and products specified in Section 07 22 00, ROOF AND DECK INSULATION (roof insulation, cover, board, vapor retarder, adhesives, and other component accessories) from single manufacturer or from sources recommended by roofing system manufacturer and incorporated in manufacturer's warranty.
- D. Roofing system design standard requirements:
1. Recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to modified bituminous sheet roofing for storage, handling and application.
  2. Recommendations of FM Approvals 1-49 Loss Prevention Data Sheet for Perimeter Flashings.
  3. Recommendations of ANSI/SPRI ES-1 for roof edge design.
  4. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
  5. FM Approvals Listing: Provide roofing membrane, base flashing, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a roofing system and that are listed in FM Approvals "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
    - a. Fire/Windstorm Classification: Class 1A-90.
    - b. Hail Resistance: MH.
- E. Pre-Roofing Meeting:
1. Upon completion of roof deck installation and prior to any roofing application, hold a pre-roofing meeting arranged by the Contractor and attended by the Roofing Inspector, Material Manufacturers Technical Representative, Roofing Applicator, Contractor, and Resident Engineer.
  2. Discuss specific expectations and responsibilities, construction procedures, specification requirements, application, environmental conditions, job and surface readiness, material storage, and protection.
  3. Inspect roof deck at this time to:
    - a. Verify that work of other trades which penetrates roof deck is completed.
    - b. Determine adequacy of deck anchorage, presence of foreign material, moisture and unlevel surfaces, or other conditions that would prevent application of roofing system from commencing or cause a roof failure.
    - c. Examine samples and installation instructions of manufacturer.

## **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, SAMPLES.
- B. Product Data:
  - 1. Adhesive materials.
  - 2. Modified bituminous sheet roofing and flashing membrane.
  - 3. Roofing adhesive.
  - 4. Roof walkway.
  - 5. Fastening requirements.
  - 6. Application instructions.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
  - 3. Product Test Reports for Credit SS 7.2: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
  - 4. Product Data for Credit IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
  - 5. Product Data for Federally-Mandated Bio-Based Materials: For roof materials, indicating USDA designation and compliance with definitions for bio-based products, Rapidly Renewable Materials, and certified sustainable wood content.
- D. Samples:
  - 1. Nails and fasteners, each type.
- E. Shop Drawings: Include plans, sections, details, and attachments.
  - 1. Base flashings and terminations.
  - 2. Nailers and cants.
- F. Certificates:
  - 1. Indicating materials and method of application of roofing system meets requirements of FM Approvals "RoofNav" for specified fire/windstorm classification.
  - 2. Indicating compliance with load/strain properties requirement.
  - 3. Indicating compliance with energy performance requirement.

- G. Warranty: As specified.
- H. Documentation of supervisors' and inspectors' qualifications.
- I. Field reports of roofing inspector.
- J. Temporary protection plan. Include list of proposed temporary materials.
- K. Contract Close-out Submittals:
  - 1. Maintenance Manuals.
  - 2. Warranty signed by installer and manufacturer.

#### **1.7 DELIVERY, STORAGE AND MARKING**

- A. Comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to built-up roofing for storage, handling and installation.

#### **1.8 ENVIRONMENTAL REQUIREMENTS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Environmental Controls: Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- C. Protection of interior spaces: Refer to Section 01 00 00, GENERAL REQUIREMENTS.

#### **1.9 WARRANTY**

- A. Roofing work subject to the terms of the Article "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's specialty warranty as follows:
  - 1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.
    - a. Special warranty includes membrane roofing, base flashings, roof insulation, roofing adhesives, coverboards, vapor retarders, and other components of membrane roofing system.
    - b. Warranty Period: 10 years.
  - 2. Installer's Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, roofing adhesives, cover boards, vapor retarders, and other components of membrane roofing system.
    - a. Warranty Period: 10 years.

## **PART 2 - PRODUCTS**

### **2.1 ADHESIVE AND ASPHALT MATERIALS**

- A. General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use, identical to materials utilized in approved listed roofing system, and compatible with roofing membrane.
  - 1. Liquid-type auxiliary materials shall comply with VOC limits of the Bay Area Air Quality Management District (BAAQMD), Regulation 8, Rule 51, Adhesive and Sealant Products; and Regulation 8, Rule 51, Architectural Coatings; when calculated according to 40 CFR 59, Subpart D (EPA Method 24):. . . Additionally, liquid-type auxiliary materials applied inside the weatherproofing shall comply with VOC content limits of LEED NC, whichever is more restrictive.
  - 2. VOC Content of Sealants:
    - a. Architectural Sealants: 250 g/L.
    - b. Sealant Primers for Nonporous Substrates: 250 g/L.
    - c. Sealant Primers for Porous Substrates: 775 g/L.
  - 3. VOC Content of Adhesives:
    - a. By application type:
      - 1) Multipurpose construction adhesives: 70 g/L.
    - b. By substrate type:
      - 1) Metal: 30 g/L.
      - 2) Porous Materials: 120 g/L.
      - 3) Other Substrates: 250 g/L.
  - 4. VOC Content of Coatings:
    - a. Roof Coatings: 50 g/L.
  - 5. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Multipurpose Construction Adhesives: 70 g/L.
    - b. Nonmembrane Roof Sealants: 300 g/L.
    - c. Sealant Primers for Nonporous Substrates: 250 g/L.
    - d. Sealant Primers for Porous Substrates: 775 g/L.
- B. Cold-Applied Adhesive for sheet membrane: One-part, asbestos-free, low-volatile, cold-applied adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:
  - 1. Asbestos Content, EPA 600 R13/116: None.
  - 2. Volatile Organic Compounds (VOC), maximum, ASTM D6511: Less than 250 g/L.
  - 3. Nonvolatile Content, minimum, ASTM D6511: 75 percent.
  - 4. Uniformity and Consistency, ASTM D6511: Pass.
- C. Cold-Applied Adhesive for membrane flashing: One-part, cold-applied

adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:

1. Asbestos Content, EPA 600 R13/116: None.
2. Volatile Organic Compounds (VOC), maximum, ASTM D6511: Less than 250 g/L.
3. Nonvolatile Content, minimum, ASTM D6511: 75 percent.
4. Uniformity and Consistency, ASTM D6511: Pass.

D. Roof Cement: ASTM D4586, Type II.

## **2.2 MEMBRANE AND SHEET MATERIALS**

- A. Membrane Materials, General: Provide combination of base, ply, and cap sheet materials that have been tested in combination and comply with load/strain properties performance requirement in Part 1 of this Section.
- B. Base Sheet/Membrane Ply Sheet: ASTM D6163, Grade S, Type II or III, glass-fiber-reinforced, SBS/SEBS-modified asphalt sheet, or ASTM D6162, Grade S, Type II or III, SBS/SEBS-modified asphalt sheet; smooth surfaced; suitable for application method specified, with the following minimum properties:
1. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 21 kN/m (120 lbf/in).
  2. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 890 N (200 lbf).
  3. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, at 5 percent maximum load ASTM D5147: 40 percent.
- C. Membrane Cap Sheet: ASTM D6163, Grade G, Type II, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced with a factory applied, white, reflective, acrylic coating; CRRC listed and California Title 24 Energy Code compliant; and as follows:
1. Exterior Fire-Test Exposure, ASTM E108: Class A.
  2. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 12.2 kN/m (70 lbf/in).
  3. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 440 N (100 lbf).
  4. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 7.5 percent.
  5. Low Temperature Flex, maximum, ASTM D5147, -26 deg. C (-15 deg. F).
  6. Reflectance, ASTM C1549: 71 percent.
  7. Thermal Emittance, ASTM C1371: 0.87.
  8. Solar Reflectance Index (SRI), ASTM E1980: 87.
- D. Base Flashing Backer Sheet: ASTM D4601, Type II, asphalt-impregnated and coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

## **2.3 FASTENERS**

- A. Roofing Fasteners: Factory-coated steel fasteners and metal or plastic plates, where applicable, meeting requirements of FM Approvals 4470, tested by fastener manufacturer for required pullout strength, and recommended by roofing manufacturer for application.
- B. Accessory Fasteners: Corrosion-resistant fasteners compatible with adjacent materials and recommended for application by manufacturer of component to be fastened.

## **2.4 ROOF WALKWAY**

- A. Prefabricated asphalt plank consisting of a homogeneous core of asphalt, plasticizers and inert fillers, bonded by heat and pressure between two saturated and coated sheets of felt:
  - 1. Top side of plank surfaced with ceramic granules. Granule Color: White.
  - 2. Size: Minimum 13 mm (1/2-inch) thick, manufacturer's standard size, but not less than 600 mm (24 inches) in least dimension and 600 mm (24 inches) in length.

# **PART 3 - EXECUTION**

## **3.1 EXAMINATION**

- A. Examine substrates and conditions with roofing Installer and roofing inspector to verify compliance with project requirements and suitability to accept subsequent roofing work. Correct unsatisfactory conditions before proceeding with roofing work.
- B. Do not apply roofing if roof surface will be used for subsequent work platform, storage of materials, or staging or scaffolding will be erected thereon unless system is protected.

## **3.2 PREPARATION**

- A. Complete roof deck construction prior to commencing roofing work:
  - 1. Install curbs, blocking, edge strips, nailers, cants, and other components where insulation, roofing, and base flashing is attached to, in place ready to receive insulation and roofing.
  - 2. Complete deck and insulation to provide designed drainage to working roof drains.
  - 3. Document installation of related materials to be concealed prior to installing roofing work.
- B. Dry out surfaces, including the flutes of metal deck that become wet from any cause during progress of the work before roofing work is resumed. Apply materials to dry substrates.
- C. Sweep decks to broom clean condition. Remove all dust, dirt or debris.



- D. Remove projections that might damage materials.

### **3.3 TEMPORARY PROTECTION**

- A. Install temporary protection at the end of day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent. Comply with approved temporary protection plan.
- B. Install temporary cap flashing over the top of base flashings where permanent flashings are not in place to provide protection against moisture entering the roof system through or behind the base flashing. Securely anchor in place to prevent blow off and damage by construction activities.
- C. Provide for removal of water or drainage of water away from the work.
- D. Provide temporary protection over installed roofing by means of duckboard walkways, plywood platforms, or other materials, as approved by Resident Engineer, for roof areas that are to remain intact, and that are subject to foot traffic and damage. Provide notches in sleepers to permit free drainage.

### **3.4 INSTALLATION, GENERAL**

- A. FM Approvals Installation Standard: Install roofing membrane, base flashings, wood cants, blocking, curbs, and nailers, and component materials in compliance with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system as listed in FM Approval's "RoofNav" for fire/windstorm classification indicated. Comply with recommendations in FM Approvals' Loss Prevention Data Sheet 1-49, including requirements for wood nailers and cants.
- B. NRCA Installation Standard: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations, including ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing"
- C. Manufacturer Recommendations: Comply with roofing system manufacturer's written installation recommendations.
- D. Coordination with related work: Coordinate roof operations with roof insulation and sheet metal work so that insulation and flashings are installed concurrently to permit continuous roofing operations.
- E. Installation Conditions:
  - 1. Apply dry roofing materials. Apply roofing work over dry substrates and materials.
  - 2. Apply materials within temperature range and surface and ambient conditions recommended by manufacturer.

3. Except for temporary protection, do not apply materials during damp or rainy weather, during excessive wind conditions, nor while moisture (dew, snow, ice, fog or frost) is present in any amount in or on the materials to be covered or installed:
  - a. Do not apply materials when the temperature is below 4 deg. C (40 deg. F).
  - b. Do not apply materials to substrate having temperature of 4 deg. C (40 deg. F) or less.

### **3.5 INSTALLATION OF MODIFIED BITUMEN MEMBRANE**

- A. Primer: Apply primer to substrates where recommended by roofing manufacturer, in application quantities recommended by roofing manufacturer.
- B. Cold-Applied Adhesive: Apply cold-applied adhesive in application quantities recommended by roofing manufacturer at substrate, between membrane sheets, and as glaze coat where required.
- C. Membrane Sheets:
  1. Number of Plies: 2, minimum, including base sheet and cap sheet, and additional plies as required to meet load/strain properties specified in Part 1 of this Section.
  2. Commence the laying of sheets at the low points.
  3. Roll sheets into cold-applied adhesive brushing down to firmly embed, free of wrinkles, fish mouths, blisters, bubbles, voids, air pockets or other defects that prevent complete adhesion:
  4. Cut to fit closely around pipes, roof drains, bitumen stops, and similar roof projections.
  5. Lap sheets shingle fashion starting with starter strips at right angles to slope of roof.
  6. Laps for Top Sheet and Base Sheet:
    - a. Base sheet, lapped 75 mm (three inches).
    - b. Use 450 mm (18 inch) starting widths, lap top sheet 475 mm (19 inches).
    - c. Lap end joints of sheet 150 mm (six inches). Stagger end joints in relation to end joints in adjacent and proceeding plies.
- D. Roof edges and terminations:
  1. Where nailers occur at roof edges or penetrations to receive metal base flashing, apply a continuous strip of underlayment over the nailers before the first ply sheet is applied.
  2. After membrane is installed, turn the underlayment back over the roofing, and secure in place with cold-applied adhesive before gravel stops or other metal flanges extending out onto the membrane are installed.
  3. Where cants occur at vertical surfaces, cut off roofing sheets two inches above top of cant strips, except at prefabricated curbs, scuttles and other roof accessories having integral cants, extend

membrane over cant and up vertical surface to top of curb or nailer as shown.

4. Where reglet occurs at vertical surfaces, extend plies roofing sheets up into reglet the full depth of the reglet.

### **3.6 BASE FLASHING**

- A. Provide built-up base flashing over cants and as necessary to make work watertight.
- B. Prime vertical surfaces of masonry and concrete with asphalt primer except where vented base sheet is required to provide edge venting.
- C. Apply flashing on top of roofing, up face of cant and up the face of the vertical surface, at least 200 mm (eight inches) above the roofing but not more than 350 mm (14 inches) above the roofing, generally full height beneath counter flashing or top of curb flashing.
  1. At fascia-cants, extend to top of cant and cut off at top of cant.
  2. At reglet, extend full depth into the reglet.
  3. Where venting base sheet is used with insulating concrete, do not seal edges of venting base sheet with bitumen; allow for venting.
- D. Use two plies of modified bituminous sheet.
  1. Extend the first ply 100 mm (four inches) out on the roofing, and the second ply 75 mm (three inches) beyond the first ply. Lap ends 75 mm (three inches) with joints broken 450 mm (18 inches) in each ply. Use smooth surface modified bituminous sheet for first ply.
  2. Use granular surfaced modified bitumen cap sheet.
- E. Set base flashing in a solid application of cold-applied adhesive.
  1. Set cap sheet in cold-applied adhesive with laps sealed with cold-applied adhesive.
  2. Except for venting roof edges, seal the top edge of the base flashing with roof cement.
- F. Secure top edge of base flashing with nails on a line approximately 25 mm (one inch) below top edge, spaced not more than 200 mm (eight inches) on center.
  1. Cover nail heads with roof cement.
  2. Cover the top of the base flashing with counterflashing as specified in Section 07 60 00, FLASHING AND SHEET METAL. At the fascia cants secure the top edge of the flashing with fascia compression clamp as specified in Section 07 60 00, FLASHING AND SHEET METAL.

### **3.7 STRIPPING**

- A. Coordinate to set flanges of metal flashing in roof cement on top sheet of the modified bituminous roofing and mailing to blocking with Section 07 60 00, FLASHING AND SHEET METAL.

- B. Cover that portion of the horizontal flanges of metal base flashings, gravel stops, and other flanges extending out onto the roofing with modified bituminous sheet.
- C. Extend the sheet out on the roofing 150 mm six inches beyond the edge of the metal flange. Cut edge to fit tight against vertical members of flange.
- D. Prime flange before stripping, embed sheet in cold-applied adhesive.

### **3.8 ROOF WALKWAYS**

- A. Install roof walkways where indicated.
- B. Set prefabricated planks in solid application of cold-applied adhesive. Maintain 75 mm (three inch) to 150 mm (six-inch) space between planks.

### **3.9 FIELD QUALITY CONTROL**

- A. Roofing Inspector: Owner will engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.
- B. Roofing Inspector: Contractor shall engage a qualified roofing inspector for a minimum of 5 full-time days on site to perform roof tests and inspections and to prepare start up, interim, and final reports. Roofing Inspector's quality assurance inspections shall comply with criteria established in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
  - 1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- D. Repair or remove and replace components of roofing work where test results or inspections indicate that they do not comply with specified requirements.
  - 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

### **3.10 PROTECTING AND CLEANING**

- A. Protect membrane roofing system from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of acceptance by Owner.
- C. Clean overspray and spillage from adjacent construction. Clean membrane and restore surface to like-new condition meeting solar reflectance requirements.

**3.11 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 07 60 00**

**FLASHING AND SHEET METAL**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Formed sheet metal work for wall and roof flashing, and copings, are specified in this section.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Membrane base flashings and stripping: Section 075216.13, STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE - COLD APPLIED.
- D. Flashing components of factory finished roofing and wall systems: Division 07 roofing and wall system sections.
- E. Joint Sealants: Section 07 92 00, JOINT SEALANTS.
- F. Color of factory coated exterior architectural metal and anodized aluminum: Section 09 06 00, SCHEDULE FOR FINISHES.
- G. Integral flashing components of manufactured roof specialties and accessories or equipment: Section 07 71 00, ROOF SPECIALTIES, and Division 22, PLUMBING sections and Division 23 HVAC sections.
- H. Paint materials and application: Section 09 91 00, PAINTING.
- I. Flashing of Roof Drains: Section 22 14 00, FACILITY STORM DRAINAGE.

**1.3 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. Aluminum Association (AA):
  - 1. AA-C22A41 Aluminum Chemically etched medium matte, with clear anodic coating, Class I Architectural, 0.7-mil thick
  - 2. AA-C22A42 Chemically etched medium matte, with integrally colored anodic coating, Class I Architectural, 0.7 mils thick

3. AA-C22A44 Chemically etched medium matte with electrolytically deposited metallic compound, integrally colored coating Class I Architectural, 0.7-mil thick finish
- C. American National Standards Institute/Single Ply Roofing Institute (ANSI/SPRI):
1. ANSI/SPRI ES-1-03 Wind Design for Edge Systems Used with Low Slope Roofing Systems
- D. American Architectural Manufacturers Association (AAMA):
1. AAMA 620 Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum
  2. AAMA 621 Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates
- E. ASTM International (ASTM):
1. A167-99(R2009) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  2. A653/A653M-09 Steel Sheet Zinc-Coated (Galvanized) or Zinc Alloy Coated (Galvanized) by the Hot- Dip Process
  3. B32-08 Solder Metal
  4. B209-07 Aluminum and Aluminum-Alloy Sheet and Plate
  5. B370-09 Copper Sheet and Strip for Building Construction
  6. D173-03 Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing
  7. D412-06 Vulcanized Rubber and Thermoplastic Elastomers-Tension
  8. D1187-97 (R2002) Asphalt Base Emulsions for Use as Protective Coatings for Metal
  9. D1784-08 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
  10. D3656-07 Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns
  11. D4586-07 Asphalt Roof Cement, Asbestos Free
- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
1. Architectural Sheet Metal Manual.
- G. National Association of Architectural Metal Manufacturers (NAAMM):
1. AMP 500-06 Metal Finishes Manual
- H. Federal Specification (Fed. Spec):
1. A-A-1925A Shield, Expansion; (Nail Anchors)
  2. UU-B-790A Building Paper, Vegetable Fiber



- I. International Code Commission (ICC): International Building Code: Current Edition

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Wind Uplift Forces: Resist wind uplift forces based on FM Approvals 1-28, Wind Design, and complying with FM Approvals 1-49, Perimeter Flashing, for basic wind speed and exposure as indicated on Drawings.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: For all specified items, including:
1. Flashings
  2. Copings
- C. Manufacturer's Literature and Data: For all specified items, including:
1. Two-piece counterflashing
  2. Thru wall flashing
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- E. Certificates: Indicating compliance with specified finishing requirements, from applicator and contractor.

### **PART 2 - PRODUCTS**

#### **2.1 FLASHING AND SHEET METAL MATERIALS**

- A. Stainless Steel: ASTM A167, Type 302B, dead soft temper.
- B. Galvanized Sheet: ASTM, A653.

#### **2.2 FLASHING ACCESSORIES**

- A. Solder: ASTM B32; flux type and alloy composition as required for use with metals to be soldered.
- B. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m<sup>2</sup> (6 lbs/100 sf).

- C. Bituminous Paint: ASTM D1187, Type I.
- D. Fasteners:
  - 1. Use stainless steel for stainless steel. Use galvanized steel or stainless steel for galvanized steel.
  - 2. Nails:
    - a. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
    - b. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.
  - 3. Rivets: Not less than 3 mm (1/8 inch) diameter.
  - 4. Expansion Shields: Fed Spec A-A-1925A.
- E. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.
- F. Roof Cement: ASTM D4586.
- G. Self-Adhering Flexible Flashing (SAFF): Slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
  - 1. SAFF Types:
    - a. Foil-faced SAFF: Aluminum foil-faced; minimum 0.635 mm (25 mils) thick.
    - b. Transitional Detail SAFF: Minimum 1 mm (46.8 mils).
    - c. Wall Flashing SAFF: Minimum 0.635 mm (25 mils) thick.
    - d. Pre-fabricated Corner: Hard plastic corner piece.
    - e. High-Temperature SAFF: Butyl rubber type; minimum 0.635 mm (25 mils) thick.
  - 2. SAFF Accessories:
    - a. Substrate Primer: Type recommended by SAFF manufacturer.
    - b. Mastic: Rubberized asphalt mastic, type recommended by SAFF manufacturer.

### 2.3 SHEET METAL THICKNESS

- A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:
- B. Concealed Locations (Built into Construction):
  - 1. Stainless steel: 0.25 mm (0.010 inch) thick.
- C. Exposed Locations:
  - 1. Stainless steel: 0.4 mm (0.015 inch).
- D. Thickness of galvanized steel is specified with each item.

## **2.4 FABRICATION, GENERAL**

### **A. Jointing:**

1. In general, copper, stainless steel and copper clad stainless steel joints, except expansion and contraction joints, shall be locked and soldered.
2. Jointing of stainless steel over 0.45 mm (0.018 inch) thick shall be done by lapping, riveting and soldering.
3. Joints shall conform to following requirements:
  - a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
  - b. Lap joints subject to stress shall finish not less than 25 mm (1 inch) wide and shall be soldered and riveted.
  - c. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide.
4. Flat and lap joints shall be made in direction of flow.
5. Soldering:
  - a. Pre tin both mating surfaces with solder for a width not less than 38 mm (1-1/2 inches) of stainless steel,.
  - b. Wire brush to produce a bright surface before soldering lead coated copper.
  - c. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
  - d. Completely remove acid and flux after soldering is completed.

### **B. Expansion and Contraction Joints:**

1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.
2. Space joints as shown or as specified.
3. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.
4. Fabricate joint covers of same thickness material as sheet metal served.

### **C. Cleats:**

1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.
2. Provide cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

## **2.5 FINISHES**

- A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.
- B. In accordance with NAAMM Metal Finishes Manual AMP 500, unless otherwise specified.
- C. Finish exposed metal surfaces as follows, unless specified otherwise:
  - 1. Stainless Steel: Finish No. 2B or 2D.
  - 2. Steel and Galvanized Steel:
    - a. Manufacturer's finish:
      - 1) Fluorocarbon Finish: AAMA 621, high performance organic coating.

## **2.6 THROUGH-WALL FLASHINGS**

- A. Form through-wall flashing to provide a mechanical bond or key against lateral movement in all directions. Install a sheet having 2 mm (1/16 inch) deep transverse channels spaced four to every 25 mm (one inch), or ribbed diagonal pattern, or having other deformation unless specified otherwise.
  - 1. Fabricate in not less than 2400 mm (8 feet) lengths; 3000 mm (10 feet) maximum lengths.
  - 2. Fabricate so keying nests at overlaps.

## **2.7 BASE FLASHING**

- A. Use metal base flashing at vertical surfaces intersecting built-up roofing without cant strips or where shown.
  - 1. Use stainless steel, thickness specified unless specified otherwise.
  - 2. When flashing is over 250 mm (10 inches) in vertical height or horizontal width use 0.5 mm (0.018 inch) stainless steel.
  - 3. Use stainless steel at pipe flashings.
- B. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inch) nor more than 400 mm (16 inch).
- C. Fabricate roof flange not less than 100 mm (4 inches) wide unless shown otherwise. When base flashing length exceeds 2400 mm (8 feet) form flange edge with 13 mm (1/2 inch) hem to receive cleats.
- D. Form base flashing bent from strip except pipe flashing. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.
- E. Pipe Flashing: (Other than engine exhaust or flue stack)
  - 1. Fabricate roof flange not less than 100 mm (4 inches) beyond sleeve on all sides.

2. Extend sleeve up and around pipe and flange out at bottom not less than 13 mm (1/2 inch) and solder to flange and sleeve seam to make watertight.
3. At low pipes 200 mm (8 inch) to 450 mm (18 inch) above roof:
  - a. Form top of sleeve to turn down into the pipe at least 25 mm (one inch).
  - b. Allow for loose fit around and into the pipe.
4. At high pipes and pipes with goosenecks or other obstructions which would prevent turning the flashing down into the pipe:
  - a. Extend sleeve up not less than 300 mm (12 inch) above roofing.
  - b. Allow for loose fit around pipe.

## **2.8 COUNTERFLASHING (CAP FLASHING OR HOODS)**

- A. stainless steel, unless specified otherwise.
- B. Fabricate to lap base flashing a minimum of 100 mm (4 inches) with drip:
  1. Form lock seams for outside corners. Allow for lap joints at ends and inside corners.
  2. In general, form flashing in lengths not less than 2400 mm (8 feet) and not more than 3000 mm (10 feet).
  3. Two-piece, lock in type flashing may be used in-lieu-of one piece counter-flashing.
  4. Manufactured assemblies may be used.
  5. Where counterflashing is installed at new work use an integral flange at the top designed to be extended into the masonry joint or reglet in concrete.
  6. Where counterflashing is installed at existing work use surface applied type, formed to provide a space for the application of sealant at the top edge.
- C. Two-Piece Counterflashing:
  1. Receiver to extend into masonry wall depth of masonry unit with back edge turned up 6 mm (1/4 inch) and exposed edge designed to receive and lock counterflashing upper edge when inserted.
  2. Counterflashing upper edge designed to snap lock into receiver.
- D. Where vented edge decks intersect vertical surfaces, form in one piece, shape to slope down to a point level with and in front of edge-set notched plank; then, down vertically, overlapping base flashing.

## **2.9 ENGINE EXHAUST PIPE OR FLUE OR STACK FLASHING**

- A. Flashing at penetrations through roofing shall consist of a metal collar, sheet metal flashing sleeve and hood.

- B. Fabricate collar with roof flange of 1.2 mm (0.047 inch) minimum thick stainless steel sheet.
  - 1. Fabricate inside diameter of collar 100 mm (4 inches) larger than the outside diameter of the item penetration the roofing.
  - 2. Extend collar height from structural roof deck to not less than 350 mm (14 inches) above roof surface.
  - 3. Fabricate collar roof flange not less than 100 mm (4 inches) wide.
  - 4. Option: Collar may be of steel tubing 3 mm (0.125 inch) minimum wall thickness, with not less than four, 50 mm x 100 mm x 3 mm (2 inch by 4 inch by 0.125 inch) thick tabs bottom edge evenly spaced around tube in lieu of continuous roof flange. Full butt weld joints of collar.
- C. Fabricate sleeve base flashing with roof flange of stainless steel.
  - 1. Fabricate sleeve roof flange not less than 100 mm (4 inches) wide.
  - 2. Extend sleeve around collar up to top of collar.
  - 3. Flange bottom of sleeve out not less than 13 mm (1/24 inch) and soldered to 100 mm (4 inch) wide flange to make watertight.
  - 4. Fabricate interior diameter 50 mm (2 inch) greater than collar.
- D. Fabricate hood counter flashing from same material and thickness as sleeve.
  - 1. Fabricate the same as pipe counter flashing except allow not less than 100 mm (4 inch) lap below top of sleeve and to form vent space minimum of 100 mm (4 inch) wide.
  - 2. Hem bottom edge of hood 13 mm (1/2 inch).
  - 3. Provide a 50 mm (2 inch) deep drawband.
- E. Fabricate insect screen closure between sleeve and hood. Secure screen to sleeve with sheet metal screws.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General:
  - 1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.
  - 2. Apply Sealant as specified in Section 07 92 00, JOINT SEALANTS.
  - 3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
  - 4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate. Cover holes or cracks in wood wider than 6 mm (1/4 inch) with sheet metal compatible with the roofing and flashing material used.

5. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
6. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
7. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
8. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
9. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
10. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.
11. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.
12. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:
  - a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
  - b. Paint dissimilar metal with a coat of bituminous paint.
  - c. Apply an approved caulking material between aluminum and dissimilar metal.
13. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
14. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.
15. Bitumen Stops:
  - a. Install bitumen stops for built-up roof opening penetrations through deck and at formed sheet metal gravel stops.
  - b. Nail leg of bitumen stop at 300 mm (12 inch) intervals to nailing strip at roof edge before roofing material is installed.

### **3.2 SELF-ADHERING FLEXIBLE FLASHING INSTALLATION:**

- A. General: Install in accordance with manufacturer's printed instructions.
- B. Apply SAFF and accessories only in fair weather when air and surface temperatures are above 25 degrees F.

- C. Apply SAFF over smooth, clean, and dry surfaces, free of voids, spalled areas, loose substrate, loose nails, sharp protrusions or other matter that will hinder the adhesion or uniformity of the wall flashing installation.
- D. Clean loose dust or dirt from the surface by wiping with a clean dry cloth or brush.
- E. Apply primer as recommended by manufacturer.
- F. Pre-cut SAFF to easily handled lengths. Peel release paper from roll to expose rubberized asphalt and carefully position flashing against substrate. Press firmly into place with a steel hand roller.
- G. Overlap adjacent pieces of SAFF 2 inches and roll overlap with a steel hand roller.
- H. Apply a bead of SAFF mastic along all laps, seams, top edges, cuts and penetrations and trowel into place.

### **3.3 THROUGH-WALL FLASHING**

- A. General:
  - 1. Install continuous through-wall flashing between top of concrete foundation walls and bottom of masonry building walls; at top of concrete floors; under masonry, concrete, or stone copings and elsewhere as shown.
  - 2. Where exposed portions are used as a counterflashings, lap base flashings at least 100 mm (4 inches) and use thickness of metal as specified for exposed locations.
  - 3. Terminate exterior edge beyond face of wall approximately 6 mm (1/4 inch) with drip edge where not part of counter flashing.
  - 4. Turn back edge up 6 mm (1/4 inch) unless noted otherwise where flashing terminates in mortar joint or hollow masonry unit joint.
  - 5. Terminate interior raised edge in masonry backup unit approximately 38 mm (1-1/2 inch) into unit unless shown otherwise.
  - 6. Under copings terminate both edges beyond face of wall approximately 6 mm (1/4 inch) with drip edge.
  - 7. Turn flashing up not less than 200 mm (8 inch) between masonry or behind exterior veneer.
  - 8. When flashing terminates in reglet extend flashing full depth into reglet and secure with lead or plastic wedges spaced 150 mm (6 inch) on center.
  - 9. Continue flashing around columns:
    - a. Where flashing cannot be inserted in column reglet hold flashing vertical leg against column.
    - b. Counterflash top edge with 75 mm (3 inch) wide strip of saturated cotton unless shown otherwise. Secure cotton strip with roof cement to column. Lap base flashing with cotton strip 38 mm (1 1/2 inch).



- B. Flashing at Top of Concrete Floors (except where shelf angles occur): Place flashing in horizontal masonry joint not less than 200 mm (8 inch) below floor slab and extend into backup masonry joint at floor slab 38 mm (1-1/2 inch).
- C. Flashing at Cavity Wall Construction: Where flashing occurs in cavity walls turn vertical portion up against backup under waterproofing, if any, into mortar joint. Turn up over insulation, if any, and horizontally through insulation into mortar joint.
- D. Window Sill Flashing:
  - 1. Install flashing to extend not less than 100 mm (4 inch) beyond ends of sill into vertical joint of masonry or veneer.
  - 2. Turn back edge up to terminate under window frame.
  - 3. Turn ends up 25 mm (one inch) and fold corners to form dam and extend to face of wall.
- E. Flashing at Masonry, Stone, or Precast Concrete Copings:

### **3.4 BASE FLASHING**

- A. Install where roof membrane type base flashing is not used and where shown.
  - 1. Install flashing at intersections of roofs with vertical surfaces or at penetrations through roofs, to provide watertight construction.
  - 2. Install metal flashings and accessories having flanges extending out on top of the built-up roofing before final bituminous coat and roof aggregate is applied.
  - 3. Set flanges in heavy trowel coat of roof cement and nail through flanges into wood nailers over bituminous roofing.
  - 4. Secure flange by nailing through roofing into wood blocking with nails spaced 75 mm (3 inch) on centers or, when flange over 100 mm (4 inch) wide terminate in a 13 mm (1/2 inch) folded edge anchored with cleats spaced 200 mm (8 inch) on center. Secure one end of cleat over nail heads. Lock other end into the seam.
- B. For long runs of base flashings install in lengths of not less than 2400 mm (8 feet) nor more than 3000 mm (ten feet). Install a 75 mm (3 inch) wide slip type, loose lock expansion joint filled with sealant in joints of base flashing sections over 2400 mm (8 feet) in length. Lock and solder corner joints at corners.
- C. Extend base flashing up under counter flashing of roof specialties and accessories or equipment not less than 75 mm (3 inch).

### **3.5 COUNTERFLASHING (CAP FLASHING OR HOODS)**

- A. General:
  - 1. Install counterflashing over and in conjunction with installation of base flashings, except as otherwise specified or shown.

2. Install counterflashing to lap base flashings not less than 100 mm (4 inch).
3. Install upper edge or top of counterflashing not less than 225 mm (9 inch) above top of the roofing.
4. Lap joints not less than 100 mm (4 inch). Stagger joints with relation to metal base flashing joints.
5. Use surface applied counterflashing on existing surfaces and new work where not possible to integrate into item.
6. When fastening to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Use screws to wood and sheet metal. Set fasteners in mortar joints of masonry work.

B. Two-Piece Counterflashing:

1. Where receiver is installed at new masonry coordinate to insure proper height, embed in mortar, and lap.
2. Surface applied type receiver:
  - a. Secure to face construction in accordance, with manufacturers instructions.
  - b. Completely fill space at the top edge of receiver with sealant.
3. Insert counter flashing in receiver in accordance with fabricator or manufacturer's instructions and to fit tight against base flashing.

C. Where vented edge occur install so lower edge of counterflashing is against base flashing.

D. When counterflashing is a component of other flashing install as shown.

### 3.6 REGLETS

- A. Install reglets in a manner to provide a watertight installation.
- B. Locate reglets not less than 225 mm (9 inch) nor more than 400 mm (16 inch) above roofing, and not less than 125 mm (5 inch) nor more than 325 mm (13 inch) above cant strip.
- C. Butt and align end joints or each section of reglet and securely hold in position until concrete or mortar are hardened:
1. Coordinate reglets for anchorage into concrete with formwork construction.
  2. Coordinate reglets for masonry to locate horizontally into mortar joints.

### 3.7 COPINGS

A. General:

1. On walls topped with a wood plank, install a continuous edge strip on the frontedge of the plank. Lock the coping to the edge strip with a 19 mm (3/4 inch) loose lock seam.

2. Where shown turn down roof side of coping and extend down over base flashing as specified for counter-flashing. Secure counter-flashing to lock strip in coping at continuous cleat.
3. Install ends adjoining existing construction so as to form space for installation of sealants. Sealant is specified in Section 07 92 00, JOINT SEALANTS.

B. Galvanized Steel Copings:

1. Join ends of sheets by a 19 mm (3/4 inch) locked and soldered seam, except at intervals of 9600 mm (32 feet), provide a 38 mm (1 1/2 inch) loose locked expansion joint filled with sealant or mastic.
2. At straight runs between 7200 mm (24 feet) and 19200 mm (64 feet) locate expansion joint at center.
3. At straight runs that exceed 9600 mm (32 feet) and form the leg of a corner locate the expansion joint not more than 4800 mm (16 feet) from the corner.

**3.8 ENGINE EXHAUST PIPE OR STACK FLASHING**

- A. Set collar where shown and secure roof tabs or flange of collar to structural deck with 13 mm (1/2 inch) diameter bolts.
- B. Set flange of sleeve base flashing not less than 100 mm (4 inch) beyond collar on all sides as specified for base flashing.
- C. Install hood to above the top of the sleeve 50 mm (2 inch) and to extend from sleeve same distance as space between collar and sleeve beyond edge not sleeve:
  1. Install insect screen to fit between bottom edge of hood and side of sleeve.
  2. Set collar of hood in high temperature sealant and secure with one by 3 mm (1/8 inch) bolt on stainless steel draw band type, or stainless steel worm gear type clamp. Install sealant at top of head.

**3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 07 71 00**

**ROOF SPECIALTIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies roof hatches.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color and texture of finish: Section 09 06 00, SCHEDULE FOR FINISHES. Sealant material and installation: Section 07 92 00, JOINT SEALANTS.
- D. General insulation: Section 07 21 13, THERMAL INSULATION. Rigid insulations for roofing: Section 07 22 00, ROOF AND DECK INSULATION

**1.3 QUALITY CONTROL**

- A. All roof accessories shall be the products of manufacturers regularly engaged in producing the kinds of products specified.
- B. Each accessory type shall be the same and be made by the same manufacturer.
- C. Each accessory shall be completely assembled to the greatest extent possible before delivery to the site.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples: Representative sample panel of color anodized aluminum not less than 100 mm x 100 mm (4 inch x 4 inch), except extrusions shall be a width not less than section to be used. Sample shall show coating with integral color and texture and shall include manufacturer's identifying label.
- C. Shop Drawings: Each item specified showing design, details of construction, installation and fastenings.
- D. Manufacturer's Literature and Data: Each item specified.
- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted

item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

- F. Certificates: Stating that aluminum has been given specified thickness of anodizing.

## **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
  1. RR-G-1602D Grating, Metal, Other Than Bar Type (Floor, Except for Naval Vessels)
- C. American Society for Testing and Material (ASTM):
  1. A653/A653M-10 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) By the Hot-Dip Process
  2. B209/209M-07 Aluminum and Aluminum Alloy-Sheet and Plate
  3. B221/221M-08 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  4. C612-10 Mineral Fiber Block and Board Thermal Insulation
  5. D1187-97(R2002) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
- D. National Association of Architectural Metal Manufacturers (NAAMM):
  1. AMP 500 Series Metal Finishes Manual
- E. American Architectural Manufacturers Association (AAMA):
  1. 2605-11 High Performance Organic Coatings on Architectural Extrusions and Panels.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum, Extruded: ASTM B221/B221M.
- B. Aluminum Sheet: ASTM B209/B209M.

## **2.2 ROOF HATCH (SCUTTLE)**

- A. Fabricate from aluminum with mill finish.
- B. Curb and Cover:
  - 1. Exterior facing: Minimum 2.3 mm (0.09 inch) thick sheet aluminum.
  - 2. Interior facing: Minimum 1 mm (0.04 inch) thick sheet aluminum.
  - 3. Minimum of 25 mm (one inch) thick mineral fiber insulation between facings of cover and over exterior face of curb.
  - 4. Form exterior curb facing with an integral three inch wide roof flange and cap flashing minimum 2.3 mm (0.09 inch) thick sheet aluminum.
  - 5. Form cover to lap curb and cap flashing.
  - 6. Size opening as shown.
- C. Hardware:
  - 1. Provide spring snap latch with inside and outside operating handles and padlock hasp on inside. Provide two snap latches when hinge side is over 2100 mm (7 feet) long.
  - 2. Provide pintle hinges.
  - 3. Provide automatic hold open and operating arm with enclosed torsion or compression spring lifting mechanism.
  - 4. Covers shall automatically lock in the open position at not less than 70 degrees.
  - 5. Provide weatherstripping at cover closure.
  - 6. Galvanize all hardware items.
- D. Guardrail/Safety Railing: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
  - 1. Safety railing: Pultruded, fire-retardant, fiberglass-reinforced polymer (FRP).
  - 2. Mounting brackets: 6 mm (1/4-inch) thick hot dip galvanized steel.
  - 3. Gate hinges and post guides: Fabricate from aluminum alloy and temper, 6063-T5, and Type 302 stainless steel torsion rod.
  - 4. Fastners: Type 316 stainless steel.
- E. Assembly:
  - 1. Completely shop assemble roof scuttle.
  - 2. Fully weld all joints exposed to the weather and built into the roofing.
  - 3. Finish weld smooth where exposed.
  - 4. Operation with minimum force to open and close.

## **2.3 FINISH**

- A. In accordance with NAAMM Amp 500 Series.
- B. Aluminum, Mill Finish: AA-MIX, as fabricated.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install roof specialties where shown.
- B. Secure with fasteners in accordance with manufacture's printed installation instructions and approved shop drawings unless shown otherwise.
- C. Coordinate to install insulation where shown; see Section 07 21 13, THERMAL INSULATION and Section 07 22 00, ROOF AND DECK INSULATION.
- D. Comply with section 07 92 00, JOINT SEALANTS to install sealants where manufactures installation instructions require sealant.
- E. Coordinate with roofing work for installation of items in sequence to prevent water infiltration.
  - 1. After completion of base flashing bend down cap flashing flange and secure to blocking with screws.
  - 2. Install expansion joint cover with 6 mm (1/4 inch) wide space at end joints and tension bars at 600 mm (24 inches) on center.
  - 3. Install cover plates with formed aluminum flashing concealed and centered on joint. Flashing to lap cover not less than 100 mm (4 inches).
- F. Equipment Supports: Do not anchor to insulating concrete or metal deck. Anchor only to building structure as per manufacturers recommendations.

### **3.2 PROTECTION OF ALUMINUM**

- A. Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact, by painting the contact surfaces of the dissimilar material with two coats of asphalt coating (complete coverage), or by separating the contact surfaces with a preformed neoprene tape having pressure sensitive adhesive coating on side.
- B. Paint aluminum in contact with wood, concrete and masonry, or other absorptive materials, that may become repeatedly wet, with two coats of asphalt coating.

### **3.3 ADJUSTING**

- A. Adjust roof hatch hardware to operate freely and so that cover will operate without binding, close tightly at perimeter, and latch securely.



**3.4 PROTECTION**

- A. Protect roof accessories from damage during installation and after completion of the work from subsequent construction.

**3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 84 00**

**FIRESTOPPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction.
- B. Closure of openings in walls against penetration of gases or smoke in smoke partitions.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Sealants and application: Section 079200, JOINT SEALANTS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 013323, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. List of FM, UL, or WH classification number of systems installed.
- E. Certified laboratory test reports for ASTM E814 tests for systems not listed by FM, UL, or WH proposed for use.

**1.4 DELIVERY AND STORAGE**

- A. Deliver materials in their original unopened containers with manufacturer's name and product identification.

- B. Store in a location providing protection from damage and exposure to the elements.

#### **1.5 WARRANTY**

- A. Firestopping work subject to the terms of the Article "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's five-year extended warranty.

#### **1.6 QUALITY ASSURANCE**

- A. FM, UL, or WH or other approved laboratory tested products will be acceptable.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. E84-10 Surface Burning Characteristics of Building Materials
  - 2. E814-11 Fire Tests of Through-Penetration Fire Stops
- C. Factory Mutual Engineering and Research Corporation (FM):
  - 1. Annual Issue Approval Guide Building Materials
- D. Underwriters Laboratories, Inc. (UL):
  - 1. Annual Issue Building Materials Directory
  - 2. Annual Issue Fire Resistance Directory
  - 3. 1479-10 Fire Tests of Through-Penetration Firestops
- E. Warnock Hersey (WH):
  - 1. Annual Issue Certification Listings

### **PART 2 - PRODUCTS**

#### **2.1 FIRESTOP SYSTEMS**

- A. Use either factory built (Firestop Devices) or field erected (through-Penetration Firestop Systems) to form a specific building system maintaining required integrity of the fire barrier and stop the passage of gases or smoke.
- B. Through-penetration firestop systems and firestop devices tested in accordance with ASTM E814 or UL 1479 using the "F" or "T" rating to maintain the same rating and integrity as the fire barrier being sealed. "T" ratings are not required for penetrations smaller than or equal to 100 mm (4 in) nominal pipe or 0.01 m<sup>2</sup> (16 sq. in.) in overall cross sectional area.

- C. Products requiring heat activation to seal an opening by its intumescence shall exhibit a demonstrated ability to function as designed to maintain the fire barrier.
- D. Firestop sealants used for firestopping or smoke sealing shall have following properties:
  - 1. Contain no flammable or toxic solvents.
  - 2. Have no dangerous or flammable out gassing during the drying or curing of products.
  - 3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
  - 4. When used in exposed areas, shall be capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.
- E. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials shall have following properties:
  - 1. Classified for use with the particular type of penetrating material used.
  - 2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.
  - 3. Intumescent products which would expand to seal the opening and act as fire, smoke, toxic fumes, and, water sealant.
- F. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84.
- G. FM, UL, or WH rated or tested by an approved laboratory in accordance with E814.
- H. Materials to be asbestos free.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Submit product data and installation instructions, as required by article, submittals, after an on site examination of areas to receive firestopping.

#### **3.2 PREPARATION**

- A. Remove dirt, grease, oil, loose materials, or other substances that prevent adherence and bonding or application of the firestopping or smoke stopping materials.
- B. Remove insulation on insulated pipe for a distance of 150 mm (6 inches) on either side of the fire rated assembly prior to applying the firestopping

materials unless the firestopping materials are tested and approved for use on insulated pipes.

### **3.3      INSTALLATION**

- A. Do not begin work until the specified material data and installation instructions of the proposed firestopping systems have been submitted and approved.
- B. Install firestopping systems with smoke stopping in accordance with FM, UL, WH, or other approved system details and installation instructions.
- C. Install smoke stopping seals in smoke partitions.

### **3.4      CLEAN-UP AND ACCEPTANCE OF WORK**

- A. As work on each floor is completed, remove materials, litter, and debris.
- B. Do not move materials and equipment to the next-scheduled work area until completed work is inspected and accepted by the Resident Engineer.
- C. Clean up spills of liquid type materials.

### **3.5      CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 07 92 00**

**JOINT SEALANTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Sealing of tilt-up concrete: Section 03 47 13, TILT-UP CONCRETE.
- D. Sealing of site work concrete paving: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.
- E. Firestopping penetrations: Section 07 84 00, FIRESTOPPING.
- F. Glazing: Section 08 80 00, GLAZING.
- G. Sound rated gypsum partitions/sound sealants: Section 09 29 00, GYPSUM BOARD.
- H. Mechanical Work: Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.3 QUALITY CONTROL:**

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results from a qualified testing agency based on testing current sealant formulations within a 12-month period.
  - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021.

2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
  3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
  4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to joint substrates in accordance with sealant manufacturer's recommendations:
1. Locate test joints where indicated or, if not indicated, as directed by Contracting Officer.
  2. Conduct field tests for each application indicated below:
    - a. Each type of elastomeric sealant and joint substrate indicated.
    - b. Each type of non-elastomeric sealant and joint substrate indicated.
  3. Notify Resident Engineer seven days in advance of dates and times when test joints will be erected.
  4. Arrange for tests to take place with joint sealant manufacturer's technical representative present.
- E. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:
1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this section.

#### **1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's installation instructions for each product used.
- C. Cured samples of exposed sealants for each color where required to match adjacent material.
- D. Manufacturer's Literature and Data:
  1. Caulking compound
  2. Primers
  3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.



- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- F. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

#### **1.5 PROJECT CONDITIONS:**

- A. Environmental Limitations:
  - 1. Do not proceed with installation of joint sealants under following conditions:
    - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4°C (40°F).
    - b. When joint substrates are wet.
- B. Joint-Width Conditions:
  - 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions:
  - 1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

#### **1.6 DELIVERY, HANDLING, AND STORAGE:**

- A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.
- B. Carefully handle and store to prevent inclusion of foreign materials.
- C. Do not subject to sustained temperatures exceeding 32°C (90°F) or less than 5°C (40°F).

#### **1.7 DEFINITIONS:**

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.

- C. Bond Breakers: A type of sealant backing.
- D. Filler: A sealant backing used behind a back-up rod.

**1.8 WARRANTY:**

- A. Warranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's warranty as follows:
  - 1. Exterior Silicone Sealants: 15 years.
  - 2. Exterior Polyurethane Sealants: 10 years.
  - 3. All Other Sealants: 2 years.
- B. General Warranty: Special warranty specified in this Article shall not deprive Government of other rights Government may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

**1.9 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. C509-06 Elastomeric Cellular Preformed Gasket and Sealing Material.
  - 2. C612-10 Mineral Fiber Block and Board Thermal Insulation.
  - 3. C717-10 Standard Terminology of Building Seals and Sealants.
  - 4. C834-10 Latex Sealants.
  - 5. C919-08. Use of Sealants in Acoustical Applications.
  - 6. C920-10 Elastomeric Joint Sealants.
  - 7. C1021-08 Laboratories Engaged in Testing of Building Sealants.
  - 8. C1193-09 Standard Guide for Use of Joint Sealants.
  - 9. C1330-02 (R2007) Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.
  - 10. D1056-07 Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
  - 11. E84-09 Surface Burning Characteristics of Building Materials.
- C. Sealant, Waterproofing and Restoration Institute (SWRI).
- D. The Professionals' Guide.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS - GENERAL**

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - 1. Architectural Sealants: 250 g/L.
  - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
  - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

### **2.2 SEALANTS:**

- A. S-1:
  - 1. ASTM C920, polyurethane.
  - 2. Type M.
  - 3. Class 50.
  - 4. Grade NS.
  - 5. Shore A hardness of 20-40
- B. S-2:
  - 1. ASTM C920, polyurethane.
  - 2. Type M.
  - 3. Class 25.
  - 4. Grade P.
  - 5. Use T.
  - 6. Shore A hardness of 25-40.
- C. S-3:
  - 1. ASTM C920, polyurethane.
  - 2. Type S.
  - 3. Class 25, joint movement range of plus or minus 50 percent.
  - 4. Grade NS.
  - 5. Shore A hardness of 15-25.

6. Minimum elongation of 700 percent.
- D. S-4:
1. ASTM C920 polyurethane.
  2. Type S.
  3. Class 25.
  4. Grade NS.
  5. Shore A hardness of 25-40
- E. S-6:
1. ASTM C920, silicone, neutral cure.
  2. Type S.
  3. Class: Joint movement range of plus 100 percent to minus 50 percent.
  4. Grade NS.
  5. Shore A hardness of 15-20.
  6. Minimum elongation of 1200 percent.
- F. S-7:
1. ASTM C920, silicone, neutral cure.
  2. Type S.
  3. Class 25.
  4. Grade NS.
  5. Shore A hardness of 25-30.
  6. Structural glazing application.
- G. S-8:
1. ASTM C920, silicone, acetoxo cure.
  2. Type S.
  3. Class 25.
  4. Grade NS.
  5. Shore A hardness of 25-30.
  6. Structural glazing application.
- H. S-9:
1. ASTM C920 silicone.
  2. Type S.
  3. Class 25.
  4. Grade NS.
  5. Shore A hardness of 25-30.

6. Non-yellowing, mildew resistant.

I. S-11:

1. ASTM C920 polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 35 to 50.

J. S-12:

1. ASTM C920, polyurethane.
2. Type M/S.
3. Class 25, joint movement range of plus or minus 50 percent.
4. Grade P/NS.
5. Shore A hardness of 25 to 50.

**2.3 CAULKING COMPOUND:**

- A. C-1: ASTM C834, acrylic latex.
- B. C-2: One component acoustical caulking, non drying, non hardening, synthetic rubber.

**2.4 COLOR:**

- A. Sealants used with exposed masonry shall match color of mortar joints.
- B. Sealants used with unpainted concrete shall match color of adjacent concrete.
- C. Color of sealants for other locations shall be light gray or aluminum, unless specified otherwise.
- D. Caulking shall be light gray or white, unless specified otherwise.

**2.5 JOINT SEALANT BACKING:**

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
  1. Type C: Closed-cell material with a surface skin.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

**2.6 FILLER:**

- A. Mineral fiber board: ASTM C612, Class 1.
- B. Thickness same as joint width.
- C. Depth to fill void completely behind back-up rod.

**2.7 PRIMER:**

- A. As recommended by manufacturer of caulking or sealant material.
- B. Stain free type.

**2.8 CLEANERS-NON POURIOUS SURFACES:**

- A. Chemical cleaners acceptable to manufacturer of sealants and sealant backing material, free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

**2.9 MODULAR SEALS FOR CONCRETE WALL PIPE PENETRATIONS**

- A. Modular seals for cored concrete; consisting of EPDM rubber seal that is compressed to seal the space between the sleeve and the penetrating pipe using stainless steel bolts and nuts.

**PART 3 - EXECUTION**

**3.1 INSPECTION:**

- A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.
- B. Coordinate for repair and resolution of unsound substrate materials.
- C. Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

**3.2 PREPARATIONS:**

- A. Prepare joints in accordance with manufacturer's instructions and SWRI.

- B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.
  - 1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
  - 2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
    - a. Concrete.
    - b. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
    - a. Metal.
    - b. Glass.
    - c. Glazed surfaces of ceramic tile.
- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking, or sealing compounds.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints wherever required by compound manufacturer's printed instructions.
  - 1. Apply primer prior to installation of back-up rod or bond breaker tape.
  - 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

### **3.3 BACKING INSTALLATION:**

- A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.
- B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.

- D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.
- E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

#### **3.4 SEALANT DEPTHS AND GEOMETRY:**

- A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.
- B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

#### **3.5 INSTALLATION:**

- A. General:
  - 1. Apply sealants and caulking only when ambient temperature is between 5 deg C and 38 deg C (40 deg and 100 deg F).
  - 2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
  - 3. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
  - 4. Apply caulking and sealing compound in accordance with manufacturer's printed instructions.
  - 5. Avoid dropping or smearing compound on adjacent surfaces.
  - 6. Fill joints solidly with compound and finish compound smooth.
  - 7. Tool joints to concave surface unless shown or specified otherwise.
  - 8. Finish paving or floor joints flush unless joint is otherwise detailed.
  - 9. Apply compounds with nozzle size to fit joint width.
  - 10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise.
- C. Where gypsum board partitions are of sound rated, or fire rated construction, follow requirements of ASTM C919 only to seal all cut-outs and intersections with the adjoining construction unless specified otherwise.
  - 1. Apply a 6 mm (1/4 inch) minimum bead of sealant each side of runners (tracks), including those used at partition intersections with dissimilar wall construction.



2. Coordinate with application of gypsum board to install sealant immediately prior to application of gypsum board.
3. Partition intersections: Seal edges of face layer of gypsum board abutting intersecting partitions, before taping and finishing or application of veneer plaster-joint reinforcing.
4. Openings: Apply a 6 mm (1/4 inch) bead of sealant around all cut-outs to seal openings of electrical boxes, ducts, pipes and similar penetrations. To seal electrical boxes, seal sides and backs.
5. Control Joints: Before control joints are installed, apply sealant in back of control joint to reduce flanking path for sound through control joint.

### **3.6 FIELD QUALITY CONTROL:**

- A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as recommended by sealant manufacturer:
  1. Extent of Testing: Test completed elastomeric sealant joints as follows:
    - a. Perform 10 tests for first 300 m (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
    - b. Perform one test for each 300 m (1000 feet) of joint length thereafter or one test per each floor per elevation.
- B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
- C. Inspect tested joints and report on following:
  1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
  2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
  3. Whether sealants filled joint cavities and are free from voids.
  4. Whether sealant dimensions and configurations comply with specified requirements.
- D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- F. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint

substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### **3.7 CLEANING:**

- A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.
- B. After filling and finishing joints, remove masking tape.
- C. Leave adjacent surfaces in a clean and unstained condition.

### **3.8 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.9 LOCATIONS:**

- A. Exterior Building Joints, Horizontal and Vertical:
  - 1. Metal to Metal: Type S-1, S-2
  - 2. Metal to Concrete: Type S-1
  - 3. Concrete to Concrete: Type S-1
  - 4. Threshold Setting Bed: Type S-1, S-3, S-4
- B. Metal Reglets and Flashings:
  - 1. Flashings to Wall: Type S-6
  - 2. Metal to Metal: Type S-6
- C. Sanitary Joints:
  - 1. Walls to Plumbing Fixtures: Type S-9
  - 2. Pipe Penetrations: Type S-9
- D. Horizontal Traffic Joints:
  - 1. Concrete Paving, Unit Pavers: Type S-11 or S-12
- E. High Temperature Joints over 204 degrees C (400 degrees F):
  - 1. Exhaust Pipes, Flues, Breech Stacks: Type S-7 or S-8

F. Interior Caulking:

1. Typical Narrow Joint 6 mm, (1/4 inch) or less at Walls and Adjacent Components: Types C-1 and C-2.
2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Masonry Surfaces: Types C-1 and C-2.
3. Exposed Acoustical Joint at Sound Rated Partitions Type C-2.
4. Concealed Acoustic Sealant Type S-4, C-1, and C-2.

- - - E N D - - -



**SECTION 08 11 13**

**HOLLOW METAL DOORS AND FRAMES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies steel doors, steel frames and related components.
- B. Terms relating to steel doors and frames as defined in ANSI A123.1 and as specified.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Frames fabricated of structural steel: Section 05 50 00, METAL FABRICATIONS.
- D. Door Hardware: Section 08 71 00, DOOR HARDWARE.
- E. Card readers and biometric devices: Section 28 13 00, DETECTION AND ALRM.
- F. Intrusion Alarm: Section 28 13 00, DETECTION AND ALARM.

**1.3 TESTING**

- A. An independent testing laboratory shall perform testing.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers Literature and Data:
  - 1. Fire rated doors and frames, showing conformance with NFPA 80 and Underwriters Laboratory, Inc., or Intertek Testing Services or Factory Mutual fire rating requirements .
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 SHIPMENT**

- A. Prior to shipment label each door and frame to show location, size, door swing and other pertinent information.
- B. Fasten temporary steel spreaders across the bottom of each door frame.

#### **1.6 STORAGE AND HANDLING**

- A. Store doors and frames at the site under cover.
- B. Protect from rust and damage during storage and erection until completion.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
  1. L-S-125B Screening, Insect, Nonmetallic
- C. Door and Hardware Institute (DHI):
  1. A115 Series Steel Door and Frame Preparation for Hardware, Series A115.1 through A115.17 (Dates Vary)
- D. Steel Door Institute (SDI):
  1. 113-01 Thermal Transmittance of Steel Door and Frame Assemblies
  2. 128-1997 Acoustical Performance for Steel Door and Frame Assemblies
  3. A250.8-03 Standard Steel Doors and Frames
- E. American Society for Testing and Materials (ASTM):
  1. A167-99(R2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  2. A568/568-M-07 Steel, Sheet, Carbon, and High-Strength, Low-alloy, Hot-Rolled and Cold-Rolled
  3. A1008-08 Steel, sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy and High Strength Low Alloy with Improved Formability
  4. B209/209M-07 Aluminum and Aluminum-Alloy Sheet and Plate
  5. B221/221M-08 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

- 6. D1621-04 Compressive Properties of Rigid Cellular Plastics
- 7. D3656-07 Insect Screening and Louver Cloth Woven from Vinyl Coated Glass Yarns
- 8. E90-04 Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
- F. The National Association Architectural Metal Manufacturers (NAAMM):
  - 1. Metal Finishes Manual (1988 Edition)
- G. National Fire Protection Association (NFPA):
  - 1. 80-09 Fire Doors and Fire Windows
- H. Underwriters Laboratories, Inc. (UL):
  - 1. Fire Resistance Directory
- I. Intertek Testing Services (ITS):
  - 1. Certifications Listings...Latest Edition
- J. Factory Mutual System (FM):
  - 1. Approval Guide

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Sheet Steel: ASTM A1008, cold-rolled for panels (face sheets) of doors.
- B. Anchors, Fastenings and Accessories: Fastenings anchors, clips connecting members and sleeves from zinc coated steel.

### **2.2 FABRICATION, GENERAL**

- A. Heavy Duty Doors: SDI A250.8, Level 2, Model 2 of size and design shown. Core construction types a, d, or f, for interior doors.
- B. Extra Heavy Duty Doors: SDI A250.8, Level 3, Model 2 of size and design shown. Core construction Types b, c, e, or f, for exterior doors.
- C. Fire Rated Doors (Labeled):
  - 1. Conform to NFPA 80 when tested by Underwriters Laboratories, Inc., Inchcape Testing Services, or Factory Mutual for the class of door or door opening shown.
  - 2. Fire rated labels of metal, with raised or incised markings of approving laboratory shall be permanently attached to doors.
  - 3. Close top and vertical edges of doors flush. Vertical edges shall be seamless. Apply steel astragal to the meeting stile of the active leaf of pairs of fire rated doors, except where vertical rod exit devices are specified for both leaves swinging in the same direction.

## **2.3 METAL FRAMES**

### **A. General:**

1. SDI A250.8, 1.3 mm (0.053 inch) thick sheet steel, types and styles as shown or scheduled.
2. Frames for exterior doors: Fabricate from 1.7 mm (0.067 inch) thick galvanized steel conforming to ASTM A525.
3. Frames for labeled fire rated doors and windows.
  - a. Comply with NFPA 80. Test by Underwriters Laboratories, Inc., Inchcape Testing Services, or Factory Mutual.
  - b. Fire rated labels of approving laboratory permanently attached to frames as evidence of conformance with these requirements. Provide labels of metal or engraved stamp, with raised or incised markings.
4. Knocked-down frames are not acceptable.

### **B. Reinforcement and Covers:**

1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.

### **C. Glazed Openings :**

1. Integral stop on exterior, corridor, or secure side of door.
2. Design rabbet width and depth to receive glazing material or panel shown or specified.

### **D. Frame Anchors:**

1. Floor anchors:
  - a. Where floor fills occur, provide extension type floor anchors to compensate for depth of fill.
  - b. At bottom of jamb use 1.3 mm (0.053 inch) thick steel clip angles welded to jamb and drilled to receive two 6 mm (1/4 inch) floor bolts. Use 50 mm x 50 mm (2 inch by 2 inch) 9 mm (3/8 inch) clip angle for lead lined frames, drilled for 9 mm (3/8 inch) floor bolts.
  - c. Where sill sections occur, provide continuous 1 mm (0.042 inch) thick steel rough bucks drilled for 6 mm (1/4 inch) floor bolts and frame anchor screws. Space floor bolts at 50 mm (24 inches) on center.
2. Jamb anchors:
  - a. Locate anchors on jambs near top and bottom of each frame, and at intermediate points not over 600 mm (24 inches) apart, except for fire rated frames space anchors as required by labeling authority.
  - b. Form jamb anchors of not less than 1 mm (0.042 inch) thick steel unless otherwise specified.
  - c. Anchors for stud partitions: Either weld to frame or use lock-in snap-in type. Provide tabs for securing anchor to the sides of the studs.



- d. Anchors for frames set in prepared openings:
  - 1) Steel pipe spacers with 6 mm (1/4 inch) inside diameter welded to plate reinforcing at jamb stops or hat shaped formed strap spacers, 50 mm (2 inches) wide, welded to jamb near stop.
  - 2) Drill jamb stop and strap spacers for 6 mm (1/4 inch) flat head bolts to pass thru frame and spacers.
  - 3) Two piece frames: Subframe or rough buck drilled for 6 mm (1/4 inch) bolts.
- e. Anchors for observation windows and other continuous frames set in stud partitions.
  - 1) In addition to jamb anchors, weld clip anchors to sills and heads of continuous frames over 1200 mm (4 feet) long.
  - 2) Anchors spaced 600 mm (24 inches) on centers maximum.
- f. Modify frame anchors to fit special frame and wall construction and provide special anchors where shown or required.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Plumb, align and brace frames securely until permanent anchors are set.
  - 1. Use triangular bracing near each corner on both sides of frames with temporary wood spreaders at midpoint.
  - 2. Use wood spreaders at bottom of frame if the shipping spreader is removed.
  - 3. Protect frame from accidental abuse.
  - 4. Where construction will permit concealment, leave the shipping spreaders in place after installation, otherwise remove the spreaders after the frames are set and anchored.
  - 5. Remove wood spreaders and braces only after the walls are built and jamb anchors are secured.
- B. Floor Anchors:
  - 1. Anchor the bottom of door frames to floor with two 6 mm (1/4 inch) diameter expansion bolts. Use 9 mm (3/8 inch) bolts on lead lined frames.
  - 2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
- C. Jamb Anchors:
  - 1. Anchors in masonry walls: Embed anchors in mortar. Fill space between frame and masonry wall with grout or mortar as walls are built.
  - 2. Coat frame back with a bituminous coating prior to lining of grout filling in masonry walls.

3. Secure anchors to sides of studs with two fasteners through anchor tabs. Use steel drill screws to steel studs.
4. Frames set in prepared openings: Expansion bolt to wall with 6 mm (1/4 inch) expansion bolts through spacers. Where subframes or rough bucks are used, 6 mm (1/4 inch) expansion bolts on 600 mm (24 inch) centers or power activated drive pins 600 mm (24 inches) on centers. Secure two piece frames to subframe or rough buck with machine screws on both faces.

- D. Install anchors for labeled fire rated doors to provide rating as required.

### **3.2 INSTALLATION OF DOORS AND APPLICATION OF HARDWARE**

- A. Install doors and hardware as specified in Sections Section 08 71 00, DOOR HARDWARE.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 08 33 00**

**COILING DOORS AND GRILLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies coiling doors of sizes shown, complete as specified.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Lock cylinders for cylindrical locks: Section 08 71 00, DOOR HARDWARE.
- D. Electric devices and wiring: DIVISION 26, ELECTRICAL.

**1.3 MANUFACTURER'S AND INSTALLER'S QUALIFICATIONS**

- A. Coiling doors shall be products of manufacturers regularly engaged in manufacturing items of type specified.
- B. Install items under direct supervision of manufacturer's representative or trained personnel.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. Each type of door showing details of construction, accessories and hardware, electrical and mechanical items supporting brackets for motors, location, and ratings of motors, and safety devices.
  - 2. Wiring diagrams for motors and controls, including wiring diagram for door, showing electrical interlock of motor with manually operated dead lock, electrical rough-in.
- C. Manufacturer's Literature and Data:
  - 1. Brochures or catalog cuts, each type door or grille.
  - 2. Manufacturer's installation procedures and instructions.
  - 3. Maintenance instructions, parts lists.

- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- E. Certificates:
1. Attesting doors, anchors and hardware will withstand the horizontal loads specified.
  2. Attesting oversize fire doors and hardware are identical in design, material, and construction to doors that meet the requirements for the class specified.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A36/A36M-08 Structural Steel
  2. A167-99(R2009) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
  3. A653/A653M-10 Steel Sheet, Zinc-Coated (Galvanized) Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  4. B209/209M-07 Aluminum and Aluminum-Alloy Sheet and Plate
  5. B221/B221M-08 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- C. National Electrical Manufacturers Association (NEMA):
1. ICS 1-00(R2008) Industrial Control and Systems General Requirements
  2. ICS 2-00(R2005) Industrial Control, and Systems, Controllers, Contactors, and Overload Relays
  3. ICS 6-93 (R2006) Industrial Control and Systems Enclosures
  4. MG 1-10 Motors and Generators
  5. ST 20-92 (R1997) Dry-Type Transformers for General Applications
- D. Master Painters Institute (MPI):
1. MPI #35 Exterior Bituminous Coating
  2. MPI #76 Quick Drying Alkyd Metal Primer

- E. National Fire Protection Association (NFPA):
  - 1. 70-11 National Electrical Code 1999 Edition
  - 2. 80-10 Fire Doors and Fire Windows
- F. National Association of Architectural Metal Manufacturers (NAAMM):
  - 1. AMP 500 Series Metal Finishes Manual
- G. Underwriters Laboratories, Inc. (UL):
  - 1. 2010 Fire Resistance Directory

## **PART 2 - PRODUCTS**

### **2.1 MATERIAL**

- A. Steel: A653 for forming operation, galvanized with G90 (Z275) zinc coating. ASTM A36 for structural sections.
- B. Bituminous Coating: MPI No. 35.

### **2.2 DESIGN REQUIREMENTS**

- A. Coiling doors shall be spring counter balanced, overhead coiling type, inside face mounted with guides at jambs set back a sufficient distance to provide a clear opening when door is in open position.
- B. Doors, hardware, and anchors shall be designed to withstand a horizontal or wind pressure of 958 Pa (20 psf) of door area without damage.
- C. All motor operators shall have manual emergency mechanical operators.

### **2.3 FABRICATION**

- A. Curtains:
  - 1. Form of interlocking slats of galvanized of shapes standard with the manufacturer, except that slats for exterior doors shall be flat type.
  - 2. Thickness of slats shall be as required to resist loads specified except not less than the following:
    - a. For doors from 4530 mm (15 feet 1 inch) to 6300 mm (21 feet wide): 0.90 mm (0.0359 inch).
  - 3. Fenestrated Slats: Approximately 76 by 16 mm (3 by 5/8 inch) openings spaced approximately 38 mm (1-1/2 inches) apart and beginning 305 mm (12 inches) from jamb guides. Fenestrations slats shall provide free open area as indicated on Drawings.
- B. Endlocks and Windlocks:
  - 1. Manufacturer's stock design of galvanized malleable iron or galvanized steel or stamped cadmium steel for doors .
  - 2. The ends of each slat for exterior doors shall have endlocks.

3. Doors shall have windlocks at ends of at least every sixth slat. Windlocks shall prevent curtain from leaving guide because of deflection from wind pressure or other forces.

C. Bottom Bar:

1. Two angles of equal weight, one on each side, standard extruded aluminum members not less than 3 mm (0.125 inch) thick.
2. Bottom bar designed to receive weather-stripping and safety device, and be securely fastened to bottom of curtain or grille.

D. Barrel and Spring Counterbalance:

1. Curtain shall coil on a barrel supported at end of opening on brackets and be balanced by helical springs.
2. Barrel fabricated of steel pipe or commercial welded steel tubing of proper diameter and thickness for the size of curtain, to limit deflection with curtain rolled up, not to exceed 1 in 400 (0.03 inch per foot) of span.
3. Close ends of barrel with cast iron plugs, machined to fit the opening.
4. Within the barrel, install an oil-tempered, helical, counter balancing steel spring, capable of producing sufficient torque to assure easy operation of the door curtain from any position.
5. At least 80 percent of the door weight shall be counter balanced at any position.
6. Spring-tension shall be adjustable from outside of bracket without removing the hood .

E. Brackets:

1. Steel plate designed to form end closure and support for hood and the end of the barrel assembly.
2. End of barrel or shaft shall screw into bracket hubs fabricated of cast iron or steel.
3. Equip bracket hubs or barrel plugs with prelubricated ball bearings, shielded or sealed.

F. Hoods:

1. Steel galvanized, 0.6 mm (0.0239 inch) thick .
2. Form hood to fit contour of end brackets.
3. Reinforce at top and bottom edges with rolled beads, rods or angles. Hoods more than 3600 mm (12 feet) in length shall have intermediate supporting brackets.
4. Fasten to brackets with screws or bolts and provide for attachment to wall with bolts.
5. Provide a weather baffle at the lintel or inside the hood of each exterior door to minimize seepage of air through the hood enclosure.

G. Guides:

1. Manufacturer's standard formed sections or angles of steel .
  - a. Steel sections not less than 5 mm (3/16 inch) thick.
2. Form a channel pocket of sufficient depth to retain the curtain in place under the horizontal pressure specified, and prevent ends of curtain from slipping out of guide slots.
3. Top sections flared for smooth entry of curtain to vertical sections that will facilitate entry of curtain.
4. Provide stops to limit curtain travel above top of guides.
5. Mounting brackets shall provide closure between guides and jams.

H. Weather-stripping:

1. Motor Operated Doors: Bottom bar safety device shall be a combination compressible seal and safety device as specified in paragraph, ELECTRIC MOTOR OPERATORS.
2. At exterior doors provide replaceable sweep type continuous vinyl or neoprene weather seals on guides and across head on exterior to seal against wind infiltration.

I. Locking:

1. Cylinder locks shall receive standard screw in cylinders furnished under Section, 08 71 00 DOOR HARDWARE.
2. For motor operated doors provide manufacturer's standard cylinder dead lock type locking device on the inside, key operated from both sides, interlocked with motor to prevent motor from operating when locks are activated.

**2.4 ELECTRIC MOTOR OPERATORS**

- A. Provide operators complete with electric motor, machine cut reduction gears, steel chain and sprockets, magnetic brake, overload protection, brackets, push button controls, limit switches, magnetic reversing contactor, and other accessories necessary for proper operation including emergency manual operator.

B. Design:

1. Design the operator so that the motor may be removed without disturbing the limit-switch timing and without affecting the emergency manual operators.
2. Make provision for emergency manual operation of door by chain-gear mechanism.
3. Arrange the emergency manual operating mechanism so that it may be immediately put into and out of operation from the floor with an electrical or mechanical device, which will disconnect the motor from the operating mechanism when the emergency manual operating mechanism is engaged, and its use shall not affect the timing of the limit switches, in case of electrical failure.

4. Provide interlock with motor to prevent motor from operating when manual locks are activated.

C. Motors:

1. Motors shall conform to NEMA MG1, suitable for operation on current of the characteristics indicated, and shall operate at not more than 3600 rpm. Single-phase motors shall not have commutation or more than one starting contact. Motor enclosures shall be the drip proof type of NEMA TENV type.
2. Motors shall be high starting torque, reversible type, of sufficient horsepower and torque output to move the door in either direction from any position, and produce a door travel speed of not less than 0.66 foot or more than one foot per second, without exceeding the rated capacity.

D. Controls:

1. The control equipment shall conform to NEMA ICS 1 and 2.
2. Control enclosures shall be NEMA ICS 6, Type 12 or Type 4, except that contractor enclosures may be Type 1.
3. Remote control switches shall be at least 1500 mm (5 feet) above the floor line, and located so that the operator will have complete visibility of the door at all times.
4. Each door motor shall have an enclosed, across-the-line type, magnetic reversing contactor, thermal overload protection, solenoid operated brake, limit switches, and remote control switches at locations shown.
5. Use key activated switches on exterior requiring constant pressure to operate.
6. Use three-button type, push button switch on interior, unless noted to be key activated, with the buttons marked, OPEN, CLOSE, and STOP.
  - a. The OPEN and STOP buttons shall be of the type requiring only momentary pressure to operate. The CLOSE button shall be of the type requiring constant pressure to maintain the closing motion of the door. When the door is in motion, and the STOP button is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door may then be operated in either direction by the OPEN or Close buttons.
  - b. Push buttons shall be full-guarded to prevent accidental operation.
7. Provide limit switches to automatically stop the doors at their fully open and closed positions. Positions of the limit switches shall be readily adjustable.
8. Safety device:
  - a. The bottom bar of power-operated doors shall have a fail safe safety device that will immediately stop and reverse the door in its closing travel upon contact with an obstruction in the door opening, or upon failure of the device, or any component of the device, or any component of the control system, and cause the door to return to its full open position. The door closing circuit shall be electrically locked out, and the door shall be operable



- manually until the failure or damage has been corrected.
  - b. Safety device shall not be used as a limit switch.
  - c. Safety device connecting cable to motor shall be flexible "Type SO" cable and spring loaded automatic take up reel or equivalent device, as required for proper operation of the doors.
9. Transformer:
- a. Provide a control transformer in power circuits as necessary to reduce the voltage on the control circuits to 120 volts or less.
  - b. The transformer shall conform to NEMA ST20.
10. Electrical components shall conform to NFPA 70. .

## **2.5 FINISHES**

- A. Steel: Baked-Enamel or powder coated finish over galvanized steel.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install doors in accordance with approved shop drawings and manufacturer's instructions.
- B. Locate anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories accurately.
- C. Securely attach guides to adjoining construction with not less than 9 mm (3/8 inch) diameter bolts, near each end and spaced not over 600 mm (24 inches) apart.
- D. Locate control switches where shown.
- E. Install all electric devices and wiring as specified in DIVISION 26 ELECTRICAL and DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

### **3.2 REPAIR**

- A. Repair prime painted zinc-coated surfaces and bare zinc-coated surfaces that are damaged by the application of galvanizing repair compound. Spot prime all damaged shop prime painted surfaces including repaired prime painted zinc-coated surfaces.
- B. Coiling Doors shall be lubricated, properly adjusted, and demonstrated to operate freely.

### **3.3 INSPECTION**

- A. Upon completion, doors shall be weathertight and doors shall be free from warp, twist, or distortion.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 08 51 13**

**ALUMINUM WINDOWS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Aluminum windows of type and size shown, complete with hardware, related components and accessories.
- B. Types:
  - 1. Fixed

**1.2 DEFINITIONS**

- A. Accessories: Mullions, staff beads, casings, closures, trim, moldings, panning systems, sub-sills, clips anchors, fasteners, weather-stripping, insect screens, and other necessary components required for fabrication and installation of window units.
- B. Uncontrolled Water: Water not drained to the exterior, or water appearing on the room side of the window.

**1.3 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Glazing: Section 08 80 00, GLAZING.
- D. Color of finish: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.4 DELIVERY, STORAGE AND HANDLING**

- A. Protect windows from damage during handling and construction operations before, during and after installation.
- B. Store windows under cover, setting upright.
- C. Do not stack windows flat.
- D. Do not lay building materials or equipment on windows.

**1.5 QUALITY ASSURANCE**

- A. Approval by contracting officer is required of products or service of proposed manufacturers and installers.

- B. Approval will be based on submission of certification by Contractor that:
  - 1. Manufacturer regularly and presently manufactures the specified windows as one of its principal products.
  - 2. Installer has technical qualifications, experience, trained personnel and facilities to install specified items.
- C. Provide each type of window produced from one source of manufacture.
- D. Quality Certified Labels or certificate:
  - 1. Architectural Aluminum Manufacturers Association, "AAMA label" affixed to each window indicating compliance with specification.
  - 2. Certificates in lieu of label with copy of recent test report (not more than 4 years old) from an independent testing laboratory and certificate signed by window manufacturer stating that windows provided comply with specified requirements and AAMA 101/I.S.2 for type of window specified.

#### **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. Minimum of 1/2 full scale.
  - 2. Identifying parts of window units by name and kind of metal or material, show construction, locking systems, mechanical operators, trim, installation and anchorages.
  - 3. Include glazing details and standards for factory glazed units.
- C. Manufacturer's Literature and Data:
  - 1. Window.
  - 2. Sash locks, keepers, and key.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- E. Certificates:
  - 1. Certificates as specified in paragraph QUALITY ASSURANCE.
  - 2. Indicating manufacturers and installers qualifications.

3. Manufacturer's Certification that windows delivered to project are identical to windows tested.

F. Test Reports:

1. Copies of test reports as specified in paragraph QUALITY ASSURANCE.

- G. Samples: Provide 150 mm (six-inch) length samples showing finishes, specified.

**1.7 WARRANTY**

- A. Warrant windows against malfunctions due to defects in thermal breaks, hardware, materials and workmanship, subject to the terms of Article "WARRANTY OF CONSTRUCTION", FAR clause 52.246-21. Provide manufacturer's 10 year special warranty.

**1.8 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
1. 90.1-07 Energy Standard of Buildings
- C. American Architectural Manufacturers Association (AAMA):
1. 101/I.S.2/A440-08 Windows, Doors, and Unit Skylights
  2. 505-09 Dry Shrinkage and Composite Performance Thermal Cycling Test Procedures
  3. 2605-05 Superior Performing Organic Coatings on Architectural Aluminum Extrusions and Panels
  4. TIR-A8-08 Structural Performance of Poured and Debridged Framing Systems
- D. American Society for Testing and Materials (ASTM):
1. A653/A653M-09 Steel Sheet, Zinc Coated (Galvanized), Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-dip Process
  2. E 90-04 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions
- E. National Fenestration Rating Council (NFRC):
1. NFRC 100-10 Determining Fenestration Product U-Factors
  2. NFRC 200-10 Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
- F. National Association of Architectural Metal Manufacturers (NAAMM):
1. AMP 500-06 Metal Finishes Manual

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum Extrusions; Sheet and Plate: AAMA 101/I.S.2.
- B. Weather-strips: AAMA 101/I.S.2.

### **2.2 THERMAL AND CONDENSATION PERFORMANCE**

- A. Condensation Resistance Factor (CRF): Minimum CRF of C 45.
- B. Solar Heat Gain Coefficient (SHGC): SHGC shall comply with State or local energy code requirement.

### **2.3 FABRICATION**

- A. Fabrication to exceed or meet requirements of Physical Load Tests, Air Infiltration Test, and Water Resistance Test of AAMA 101/I.S.2.
- B. Glazing:
  - 1. Factory or field glazing optional.
  - 2. Glaze in accordance with Section 08 80 00, GLAZING.
  - 3. Windows reglazable without dismantling sash framing.
  - 4. Design rabbet to suit glass thickness and glazing method specified.
  - 5. Glaze from interior except where not accessible.

### **2.4 FIXED WINDOWS**

- A. AMMA 101/I.S.2; Type HC25.
- B. AAMA certified product to the AAMA 101/I.S.2. - 97 standard.

### **2.5 FINISH**

- A. In accordance with NAAMM AMP 500 series.
- B. Finish exposed aluminum surfaces as follows:
  - 1. Coated Aluminum:
    - a. Fluorocarbon Finish: AAMA 2605, superior performing organic coating.

## **PART 3 - EXECUTION**

### **3.1 PROTECTION (DISSIMILAR MATERIALS):**

- A. AAMA 101/I.S.2.

### **3.2 INSTALLATION, GENERAL**

- A. Install window units in accordance with manufacturer's specifications and recommendations for installation of window units, hardware, operators and other components of work.
- B. Where type, size or spacing of fastenings for securing window accessories or equipment to building construction is not shown or specified, use expansion or toggle bolts or screws, as best suited to construction material.
  - 1. Provide bolts or screws minimum 6 mm (1/4-inch) in diameter.
  - 2. Sized and spaced to resist the tensile and shear loads imposed.
  - 3. Do not use exposed fasteners on exterior, except when unavoidable for application of hardware.
  - 4. Provide non-magnetic stainless steel Phillips flat-head machine screws for exposed fasteners, where required, or special tamper-proof fasteners.
  - 5. Locate fasteners to not disturb the thermal break construction of windows.
- C. Set windows plumb, level, true, and in alignment; without warp or rack of frames or sash.
- D. Anchor windows on four sides with anchor clips.
  - 1. Do not allow building load to bear on windows.
  - 2. Use manufacturer's standard clips at corners and not over 600 mm (24 inches) on center.
- E. Sills and Stools:
  - 1. Set in bed of mortar or other compound to fully support, true to line shown.
  - 2. Do not extend sill to inside window surface or past thermal break.
  - 3. Leave space for sealants at ends and to window frame unless shown otherwise.

### **3.3 CLOSURES, TRIM, AND PANNING**

- A. Closures, Trim, and Panning: External corners mitered and internal corners coped, fitted with hairline, tightly closed joints.
- B. Secure to concrete or solid masonry with expansion bolts, expansion rivets, split shank drive bolts, or powder actuated drive pins.
- C. Toggle bolt to hollow masonry units. Screwed to wood or metal.
- D. Fasten except for strap anchors, near ends and corners and at intervals not more than 300 mm (12 inches) between.
- E. Seal units following installation to provide weathertight system.

### **3.4 CLEANING**

- A. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage to protective coatings and finishes.
- B. Remove excess glazing and sealant compounds, dirt, and other substances.
- C. Lubricate hardware and moving parts.
- D. Clean glass promptly after installation of windows. Remove glazing and sealant compound, dirt and other substances.
- E. Except when a window is being adjusted or tested, keep locked in the closed position during the progress of work on the project.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 08 71 00**

**DOOR HARDWARE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Door hardware and related items necessary for complete installation and operation of doors.

**1.2 RELATED WORK**

- A. Caulking: Section 07 92 00 JOINT SEALANTS.
- B. Application of Hardware: Section 08 11 13, HOLLOW METAL DOORS AND FRAMES  
Section 08 33 00, COILING DOORS AND GRILLES
- C. Finishes: Section 09 06 00, SCHEDULE FOR FINISHES.
- D. Painting: Section 09 91 00, PAINTING.
- E. Card Readers: Section 28 13 00, ACCESS ALARM AND MONITORING SYSTEM.
- F. Electrical: Division 26, ELECTRICAL.
- G. Fire Detection: Section 28 31 00, FIRE DETECTION AND ALARM.

**1.3 GENERAL**

- A. All hardware shall comply with UFAS, (Uniform Federal Accessible Standards) unless specified otherwise.
- B. Provide rated door hardware assemblies where required by most current version of the International Building Code (IBC).
- C. Hardware for Labeled Fire Doors and Exit Doors: Conform to requirements of NFPA 80 for labeled fire doors and to NFPA 101 for exit doors, as well as to other requirements specified. Provide hardware listed by UL, except where heavier materials, large size, or better grades are specified herein under paragraph HARDWARE SETS. In lieu of UL labeling and listing, test reports from a nationally recognized testing agency may be submitted showing that hardware has been tested in accordance with UL test methods and that it conforms to NFPA requirements.
- D. Hardware for application on metal doors and frames shall be made to standard templates. Furnish templates to the fabricator of these items in sufficient time so as not to delay the construction.

- E. The following items shall be of the same manufacturer, if possible, except as otherwise specified:
1. Mortise locksets.
  2. Hinges for hollow metal doors.
  3. Surface applied overhead door closers.
  4. Exit devices.

#### **1.4 WARRANTY**

- A. Door hardware shall be subject to the terms of FAR Clause 52.24-21. Provide manufacturer's special warranties as follows:
1. Locks, latchsets, and panic hardware: 5 years.
  2. Door closers: 10 years.
  3. Other hardware: 2 years.

#### **1.5 MAINTENANCE MANUALS**

- A. In accordance with Section 01 00 00, GENERAL REQUIREMENTS Article titled "INSTRUCTIONS", furnish maintenance manuals and instructions on all door hardware.

#### **1.6 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. Submit 6 copies of the schedule per Section 01 33 23 plus 2 copies to the VAMC Locksmith (VISN Locksmith if the VAMC does not have a locksmith).
- B. Hardware Schedule: Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (if fire rated and listed)	ANSI/BHMA Finish Designation

- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

D. Samples and Manufacturers' Literature:

1. Samples: All hardware items (proposed for the project) that have not been previously approved by Builders Hardware Manufacturers Association shall be submitted for approval. Tag and mark all items with manufacturer's name, catalog number and project number.
2. Samples are not required for hardware listed in the specifications by manufacturer's catalog number, if the contractor proposes to use the manufacturer's product specified.

E. Certificate of Compliance and Test Reports: Submit certificates that hardware conforms to the requirements specified herein. Certificates shall be accompanied by copies of reports as referenced. The testing shall have been conducted either in the manufacturer's plant and certified by an independent testing laboratory or conducted in an independent laboratory, within four years of submittal of reports for approval.

**1.7 DELIVERY AND MARKING**

- A. Deliver items of hardware to job site in their original containers, complete with necessary appurtenances including screws, keys, and instructions. Tag one of each different item of hardware and deliver to Resident Engineer for reference purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in Resident Engineer's office until all other similar items have been installed in project, at which time the Resident Engineer will deliver items on file to Contractor for installation in predetermined locations on the project.

**1.8 PREINSTALLATION MEETING**

- A. Convene a preinstallation meeting not less than 30 days before start of installation of door hardware. Require attendance of parties directly affecting work of this section, including Contractor and Installer, Architect, Project Engineer and VA Locksmith, Hardware Consultant, and Hardware Manufacturer's Representative. Review the following:
1. Inspection of door hardware.
  2. Job and surface readiness.
  3. Coordination with other work.
  4. Protection of hardware surfaces.
  5. Substrate surface protection.
  6. Installation.
  7. Adjusting.
  8. Repair.
  9. Field quality control.
  10. Cleaning.

**1.9 INSTRUCTIONS**

- A. Hardware Set Symbols on Drawings: Except for protective plates, door stops, muted, thresholds and the like specified herein, hardware requirements for each door are indicated on drawings by symbols. Symbols for hardware sets consist of letters (e.g., "HW") followed by a number. Each number designates a set of hardware items applicable to a door type.
- B. Manufacturers' Catalog Number References: Where manufacturers' products are specified herein, products of other manufacturers which are considered equivalent to those specified may be used. Manufacturers whose products are specified are identified by abbreviations as follows:

Adams-Rite	Adams Rite Mfg. Co.	Pomona, CA
Best	Best Access Systems	Indianapolis, IN
Don-Jo	Don-Jo Manufacturing	Sterling, MA
G.E. Security	GE Security, Inc.	Bradentown, FL
Markar	Markar Architectural Products	Pomona, CA
Pemko	Pemko Manufacturing Co.	Ventura, CA
Rixson	Rixson	Franklin Park, IL
Rockwood	Rockwood Manufacturing Co.	Rockwood, PA
Securitron	Securitron Magnalock Corp.	Sparks, NV
Southern Folger	Southern Folger Detention Equipment Co.	San Antonio, TX
Stanley	The Stanley Works	New Britain, CT
Tice	Tice Industries	Portland, OR
Trimco	Triangle Brass Mfg. Co.	Los Angeles, CA
Zero	Zero Weather Stripping Co.	New York, NY

- C. Keying: All cylinders shall be keyed into existing Grand Master Key System. Provide removable core cylinders that are removable only with a special key or tool without disassembly of knob or lockset. Cylinders shall be 7 pin type. Keying information shall be furnished at a later date by the Resident Engineer.

**1.10 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. In text, hardware items are referred to by series, types, etc., listed in such specifications and standards, except as otherwise specified.
- B. American Society for Testing and Materials (ASTM):
1. F883-04 Padlocks
  2. E2180-07 Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) In Polymeric or Hydrophobic Materials

C. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):

1. A156.1-06 Butts and Hinges
2. A156.2-03 Bored and Pre-assembled Locks and Latches
3. A156.3-08 Exit Devices, Coordinators, and Auto Flush Bolts
4. A156.4-08 Door Controls (Closers)
5. A156.5-01 Auxiliary Locks and Associated Products
6. A156.6-05 Architectural Door Trim
7. A156.8-05 Door Controls-Overhead Stops and Holders
8. A156.12-05 Interconnected Locks and Latches
9. A156.13-05 Mortise Locks and Latches Series 1000
10. A156.14-07 Sliding and Folding Door Hardware
11. A156.15-06 Release Devices-Closer Holder, Electromagnetic and Electromechanical
12. A156.16-08 Auxiliary Hardware
13. A156.17-04 Self-Closing Hinges and Pivots
14. A156.18-06 Materials and Finishes
15. A156.20-06 Strap and Tee Hinges, and Hasps
16. A156.21-09 Thresholds
17. A156.22-05 Door Gasketing and Edge Seal Systems
18. A156.23-04 Electromagnetic Locks
19. A156.24-03 Delayed Egress Locking Systems
20. A156.25-07 Electrified Locking Devices
21. A156.26-06 Continuous Hinges
22. A156.28-07 Master Keying Systems
23. A156.29-07 Exit Locks and Alarms
24. A156.30-03 High Security Cylinders
25. A156.31-07 Electric Strikes and Frame Mounted Actuators
26. A250.8-03 Standard Steel Doors and Frames

D. National Fire Protection Association (NFPA):

1. 80-10 Fire Doors and Fire Windows
2. 101-09 Life Safety Code

E. Underwriters Laboratories, Inc. (UL):

F. Building Materials Directory (2008)

## **PART 2 - PRODUCTS**

### **2.1 BUTT HINGES**

- A. ANSI A156.1. Provide only three-knuckle hinges, except five-knuckle where the required hinge type is not available in a three-knuckle version (e.g., some types of swing-clear hinges). The following types of butt hinges shall be used for the types of doors listed, except where otherwise specified:
1. Exterior Doors: Type A5112 (stainless steel material). Hinges for exterior outswing doors shall have non-removable pins.
  2. Interior Doors: Type A8112/A5112 for doors 900 mm (3 feet) wide or less and Type A8111/A5111 for doors over 900 mm (3 feet) wide. Hinges for doors exposed to high humidity and corrosive areas (toilet rooms, janitor rooms, ammonia SCR room, etc. shall be of stainless steel material.
- B. Provide quantity and size of hinges per door leaf as follows:
1. Doors up to 1210 mm (4 feet) high: 2 hinges.
  2. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
  3. Doors greater than 2260 mm (7 feet 5 inches) high: 4 hinges.
  4. Doors up to 900 mm (3 feet) wide, standard weight: 114 mm x 114 mm (4-1/2 inches x 4-1/2 inches) hinges.
  5. Doors over 900 mm (3 feet) to 1065 mm (3 feet 6 inches) wide, standard weight: 127 mm x 114 mm (5 inches x 4-1/2 inches).
  6. Doors over 1065 mm (3 feet 6 inches) to 1210 mm (4 feet), heavy weight: 127 mm x 114 mm (5 inches x 4-1/2 inches).
  7. Provide heavy-weight hinges where specified.
  8. At doors weighing 330 kg (150 lbs.) or more, furnish 127 mm (5 inch) high hinges.
- C. See Articles "MISCELLANEOUS HARDWARE" and "HARDWARE SETS" for pivots and hinges other than butts specified above and continuous hinges specified below.

### **2.2 DOOR CLOSING DEVICES**

- A. Closing devices shall be products of one manufacturer

### **2.3 OVERHEAD CLOSERS**

- A. Conform to ANSI A156.4, Grade 1.
- B. Closers shall conform to the following:
1. The closer shall have minimum 50 percent adjustable closing force over minimum value for that closer and have adjustable hydraulic back check effective between 60 degrees and 85 degrees of door opening.
  2. Where specified, closer shall have hold-open feature.

3. Size Requirements: Provide multi-size closers, sizes 1 through 6, except where multi-size closer is not available for the required application.
4. Material of closer body shall be forged or cast.
5. Arm and brackets for closers shall be steel, malleable iron or high strength ductile cast iron.
6. Where closers are exposed to the exterior or are mounted in rooms that experience high humidity, provide closer body and arm assembly of stainless steel material.
7. Closers shall have full size metal cover; plastic covers will not be accepted.
8. Closers shall have adjustable hydraulic back-check, separate valves for closing and latching speed, adjustable back-check positioning valve, and adjustable delayed action valve.
9. Provide closers with any accessories required for the mounting application, including (but not limited to) drop plates, special soffit plates, spacers for heavy-duty parallel arm fifth screws, bull-nose or other regular arm brackets, longer or shorter arm assemblies, and special factory templating. Provide special arms, drop plates, and templating as needed to allow mounting at doors with overhead stops and/or holders.
10. Closer arms or backcheck valve shall not be used to stop the door from overswing, except in applications where a separate wall, floor, or overhead stop cannot be used.
11. Provide parallel arm closers with heavy duty rigid arm.
12. Where closers are to be installed on the push side of the door, provide parallel arm type except where conditions require use of top jamb arm.
13. Provide all surface closers with the same body attachment screw pattern for ease of replacement and maintenance.
14. All closers shall have a 1-1/2 inch (38mm) minimum piston diameter.

#### **2.4 DOOR STOPS**

- A. Conform to ANSI A156.16.
- B. Provide door stops wherever an opened door or any item of hardware thereon would strike a wall, column, equipment or other parts of building construction. For concrete, masonry or quarry tile construction, use lead expansion shields for mounting door stops.
- C. Where cylindrical locks with turn pieces or pushbuttons occur, equip wall bumpers Type L02251 (rubber pads having concave face) to receive turn piece or button.
- D. Provide floor stops (Type L02141 or L02161 in office areas; Type L02121 x 3 screws into floor elsewhere. Wall bumpers, where used, must be installed to impact the trim or the door within the leading half of its width. Floor stops, where used, must be installed within 4-inches of the wall face and impact the door within the leading half of its width.

- E. Where drywall partitions occur, use floor stops, Type L02141 or L02161 in office areas, Type L02121 elsewhere.
- F. Where the specified wall or floor stop cannot be used, provide concealed overhead stops (surface-mounted where concealed cannot be used).

## 2.5 LOCKS AND LATCHES

- A. Conform to ANSI A156.2. Locks and latches for doors 45 mm (1-3/4 inch) thick or over shall have beveled fronts. Lock cylinders shall have not less than seven pins. Cylinders for all locksets shall be removable core type. Cylinders shall be furnished with construction removable cores and construction master keys. Cylinder shall be removable by special key or tool. Construct all cores so that they will be interchangeable into the core housings of all mortise locks, rim locks, cylindrical locks, and any other type lock included in the Great Grand Master Key System. Disassembly of lever or lockset shall not be required to remove core from lockset. All locksets or latches on double doors with fire label shall have latch bolt with 19 mm (3/4 inch) throw, unless shorter throw allowed by the door manufacturer's fire label. Provide temporary keying device or construction core of allow opening and closing during construction and prior to the installation of final cores.
- B. In addition to above requirements, locks and latches shall comply with following requirements:
  - 1. Mortise Lock and Latch Sets: Conform to ANSI/BHMA A156.13. Mortise locksets shall be series 1000, minimum Operational Grade 1 and Security Grade 2. All locksets and latchsets, shall have lever handles fabricated from cast stainless steel. Provide sectional (lever x rose) curved lever design with a return to within 12 mm (1/2 inch) of the door, and 54 mm (2-1/8 inch) diameter rose. Provide multi-functional lock body, which allows field modifications of lock functions. All locks and latchsets shall be furnished with 122.55 mm (4-7/8-inch) curved lip strike and wrought box. At outswing pairs with overlapping astragals, provide flat lip strip with 21mm (7/8-inch) lip-to-center dimension. Lock function F02 shall be furnished with emergency tools/keys for emergency entrance. All lock cases installed on lead lined doors shall be lead lined before applying final hardware finish. Furnish armored fronts for all mortise locks. Where mortise locks are installed in high-humidity locations or where exposed to the exterior on both sides of the opening, provide non-ferrous mortise lock case.

## 2.6 KEYS

- A. Stamp all keys with change number and key set symbol. Furnish keys in quantities as follows:

Locks/Keys	Quantity
Cylinder locks	2 keys each
Cylinder lock change key blanks	100 each different key way
Master-keyed sets	6 keys each
Control key	2 keys



## **2.7 ARMOR PLATES, KICK PLATES, MOP PLATES AND DOOR EDGING**

- A. Conform to ANSI Standard A156.6.
- B. Provide protective plates as specified below:
  - 1. Kick plates, mop plates and armor plates of metal, Type J100 series.
  - 2. Provide kick plates and mop plates where specified. Kick plates shall be 254 mm (10 inches) or 305 mm (12 inches) high. Mop plates shall be 152 mm (6 inches) high. Both kick and mop plates shall be minimum 1.27 mm (0.050 inches) thick. Provide kick and mop plates beveled on all 4 edges (B4E). On push side of doors where jamb stop extends to floor, make kick plates 38 mm (1-1/2 inches) less than width of door, except pairs of metal doors which shall have plates 25 mm (1 inch) less than width of each door. Extend all other kick and mop plates to within 6 mm (1/4 inch) of each edge of doors. Kick and mop plates shall butt astragals. For jamb stop requirements, see specification sections pertaining to door frames.
  - 3. Kick plates and/or mop plates are not required on following door sides:
    - a. Armor plate side of doors;
    - b. Exterior side of exterior doors;
  - 4. Armor plates for doors are listed under Article "Hardware Sets". Armor plates shall be thickness as noted in the hardware set, 875 mm (35 inches) high and 38 mm (1-1/2 inches) less than width of doors, except on pairs of metal doors. Provide armor plates beveled on all 4 edges (B4E). Plates on pairs of metal doors shall be 25 mm (1 inch) less than width of each door. Where top of intermediate rail of door is less than 875 mm (35 inches) from door bottom, extend armor plates to within 13 mm (1/2 inch) of top of intermediate rail. On doors equipped with panic devices, extend armor plates to within 13 mm (1/2 inch) of panic bolt push bar.

## **2.8 EXIT DEVICES**

- A. Conform to ANSI Standard A156.3. Exit devices shall be Grade 1; type and function are specified in hardware sets. Provide flush with finished floor strikes for vertical rod exit devices in interior of building. Trim shall have cast satin stainless steel lever handles of design similar to locksets, unless otherwise specified. Provide key cylinders for keyed operating trim and, where specified, cylinder dogging.
- B. Concealed vertical rod panics shall be provided less bottom rod at interior doors, unless lockable or otherwise specified; provide fire pins as required by exit device and door fire labels. Where concealed vertical rod panics are specified at exterior doors, provide with both top and bottom rods.
- C. Exit devices for fire doors shall comply with Underwriters Laboratories, Inc., requirements for Fire Exit Hardware. Submit proof of compliance.

## **2.9 FLUSH BOLTS (AUTOMATIC)**

- A. Conform to ANSI A156.3. Dimension of flush bolts shall conform to ANSI A115. Bolts shall conform to Underwriters Laboratories, Inc., requirements for fire door hardware. Flush bolts shall automatically latch and unlatch. Furnish dustproof strikes conforming to ANSI A156.16 for bottom flushbolt. Face plates for dustproof strike shall be rectangular and not less than 38 mm by 90 mm (1-1/2 by 3-1/2 inches).
- B. At interior doors, provide auto flush bolts less bottom bolt, unless otherwise specified, except at wood pairs with fire-rating greater than 20 minutes; provide fire pins as required by auto flush bolt and door fire labels.

## **2.10 COORDINATORS**

- A. Conform to ANSI A156.16. Coordinators, when specified for fire doors, shall comply with Underwriters Laboratories, Inc., requirements for fire door hardware. Coordinator may be omitted on exterior pairs of doors where either door will close independently regardless of the position of the other door. Coordinator may be omitted on interior pairs of non-labeled open where open back strike is used. Open back strike shall not be used on labeled doors. Paint coordinators to match door frames, unless coordinators are plated. Provide bar type coordinators, except where gravity coordinators are required at acoustic pairs. For bar type coordinators, provide filler bars for full width and, as required, brackets for push-side surface mounted closers, overhead stops, and vertical rod panic strikes.

## **2.11 THRESHOLDS**

- A. Conform to ANSI A156.21, mill finish extruded aluminum, except as otherwise specified. In existing construction, thresholds shall be installed in a bed of sealant with ¼-20 stainless steel machine screws and expansion shields. In new construction, embed aluminum anchors coated with epoxy in concrete to secure thresholds. Furnish thresholds for the full width of the openings.
- B. At exterior doors and any interior doors exposed to moisture, provide threshold with non-slip abrasive finish.
- C. Provide with miter returns where threshold extends more than 12 mm (0.5 inch) from fame face.

## **2.12 WEATHERSTRIPS (For Exterior Doors)**

- A. Conform to ANSI A156.22. Air leakage shall not to exceed 0.50 CFM per foot of crack length (0.000774m<sup>3</sup>/s/m).

## **2.13 MISCELLANEOUS HARDWARE**

- A. Cylinders for Various Partitions and Doors: Key cylinders same as entrance doors of area in which partitions and door occur, . Provide cylinders to

operate locking devices where specified for following partitions and doors:

1. Slide-up doors.

- B. Mutes: Conform to ANSI A156.16. Provide door mutes or door silencers Type L03011 or L03021, depending on frame material, of white or light gray color, on each steel door frame, except at fire-rated frames, and frames for sound-resistant doors. Furnish 3 mutes for single doors and 2 mutes for each pair of doors, except double-acting doors.

## **2.14 FINISHES**

- A. Exposed surfaces of hardware shall have ANSI A156.18, finishes as specified below. Finishes on all hinges, pivots, closers, thresholds, etc., shall be as specified below under "Miscellaneous Finishes." For field painting (final coat) of ferrous hardware, see Section 09 91 00, PAINTING.
- B. 626 or 630: All surfaces on exterior and interior of buildings, except where other finishes are specified.
- C. Miscellaneous Finishes:
1. Hinges --exterior doors: 626 or 630.
  2. Hinges --interior doors: 652 or 630.
  3. Door Closers: Factory applied paint finish. Dull or Satin Aluminum color.
  4. Thresholds: Mill finish aluminum.
  5. Other primed steel hardware: 600.

## **2.15 BASE METALS**

- A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
652	Steel
626	Brass or bronze
630	Stainless steel

## **PART 3 - EXECUTION**

### **3.1 HARDWARE HEIGHTS**

- A. For new buildings locate hardware on doors at heights specified below, with all hand-operated hardware centered within 864 mm (34 inches) to 1200 mm (48 inches), unless otherwise noted:

B. Hardware Heights from Finished Floor:

1. Exit devices centerline of strike (where applicable) 1024 mm (40-5/16 inches).
2. Locksets and latch sets centerline of strike 1024 mm (40-5/16 inches).
3. Locate other hardware at standard commercial heights. Locate push and pull plates to prevent conflict with other hardware.

**3.2 INSTALLATION**

- A. Closer devices, including those with hold-open features, shall be equipped and mounted to provide maximum door opening permitted by building construction or equipment. Closers shall be mounted on side of door inside rooms, inside stairs, and away from corridors. At exterior doors, closers shall be mounted on interior side. Where closers are mounted on doors they shall be mounted with sex nuts and bolts; foot shall be fastened to frame with machine screws.

B. Hinge Size Requirements:

Door Thickness	Door Width	Hinge Height
45 mm (1-3/4 inch)	900 mm (3 feet) and less	113 mm (4-1/2 inches)
45 mm (1-3/4 inch)	Over 900 mm (3 feet) but not more than 1200 mm (4 feet)	125 mm (5 inches)
35 mm (1-3/8 inch) (hollow core wood doors)	Not over 1200 mm (4 feet)	113 mm (4-1/2 inches)

- C. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

D. Hinges Required Per Door:

Doors 1500 mm (5 ft) or less in height	2 butts
Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts
Doors over 2280 mm (7 feet 6 inches) high	4 butts
Dutch type doors	4 butts
Doors with spring hinges 1370 mm (4 feet 6 inches) high or less	2 butts
Doors with spring hinges over 1370 mm (4 feet 6 inches)	3 butts

- E. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Provide machine screws and lead expansion shields to secure hardware to concrete, ceramic or quarry floor tile, or solid masonry. Fiber or rawl plugs and adhesives are not permitted. All fastenings exposed to weather shall be of nonferrous metal.
- F. After locks have been installed; show in presence of Resident Engineer that keys operate their respective locks in accordance with keying

requirements. (All keys, Master Key level and above shall be sent Registered Mail to the Medical Center Director along with the bitting list. Also a copy of the invoice shall be sent to the Resident Engineer for his records.) Installation of locks which do not meet specified keying requirements shall be considered sufficient justification for rejection and replacement of all locks installed on project.

### 3.3 FINAL INSPECTION

- A. Installer to provide letter to VA Resident/Project Engineer that upon completion, installer has visited the Project and has accomplished the following:
1. Re-adjust hardware.
  2. Evaluate maintenance procedures and recommend changes or additions, and instruct VA personnel.
  3. Identify items that have deteriorated or failed.
  4. Submit written report identifying problems.

### 3.4 DEMONSTRATION

- A. Demonstrate efficacy of mechanical hardware and electrical, and electronic hardware systems, including adjustment and maintenance procedures, to satisfaction of Resident/Project Engineer and VA Locksmith.

### 3.5 HARDWARE SETS

- A. Following sets of hardware correspond to hardware symbols shown on drawings. Only those hardware sets that are shown on drawings will be required. Disregard hardware sets listed in specifications but not shown on drawings.

#### INTERIOR SINGLE DOORS

		HW-2G
Each Door to Have:		NON-RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Keyed Privacy Indicator Lock	F13 x OCCUPANCY INDICATOR
1	Closer	C02011/C02021 (PT4D, PT4H)
1	Kick Plate	J102
1	Wall Stop	L52101 CONVEX
1	Floor Stop	L02121 x 3 FASTENERS
1	Set Perimeter Gasketing with concealed fasteners	R3A164

HW-3F

Each Door to Have:		NON-RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Office Lock	F04
1	Closer	CO2011/CO2021 (PT4D, PT4H)
1	Wall Stop	L52101 CONVEX
1	Threshold	J32300 x 100 mm width (4 inches)
1	Auto Door Bottom	R3G325
1	Set Perimeter Gasketing with concealed fasteners	R3A164

HW-4D

Each Door to Have:		NON-RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Classroom Lock	F08
1	Closer	CO2011/CO2021 (PT4D, PT4H)
1	Wall Stop	L52101 CONVEX
1	Set Self-Adhesive Seals	R0E154

HW-4E

Each Door to Have:		RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Classroom Lock	F08
1	Closer	CO2011/CO2021 (PT4D, PT4H)
1	Wall Stop	L52101 CONVEX
1	Threshold	J32300 x 100 mm width (4 inches)
1	Sets Self-Adhesive Seals	R0E154

HW-6A

Each Door to Have:		NON-RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Exit Device	TYPE 1 F14 LEVER
1	Closer	CO2011/CO2021 (PT4D, PT4H)
1	Floor Stop	L02121 x 3 FASTENERS
1	Set Self-Adhesive Seals	R0E154

HW-10D

Each Pair to Have:		NON-RATED
	Hinges	QUANTITY & TYPE AS REQUIRED
1	Self-Latching Flush Bolt	TYPE 25
1	Set Auto Flush Bolts	TYPE 25
1	Classroom Lock	F08
1	Overlapping Astragal with Self-Adhesive Seal	R5Y634 x R0E154 x THRU-BOLTS
2	Overhead Stop	C01541-ADJUSTABLE
1	Set Self-Adhesive Seals	R0E154

SECURITY HARDWARE ABBREVIATIONS LEGEND:

AC = Access Control Device (Card reader, biometric reader, keypad, etc.)  
DPS = Door Position Switch (Door or Alarm Contact)  
EL = Electric Lock or Electric Lever Exit Device  
REX = Request-to-Exit Switch in Latching Device Inside Trim

INTERIOR SINGLE SECURITY DOORS

HW-SH-3

Each AC, EL, REX, DPS Door to Have: RATED/NON-RATED

	Hinges	QUANTITY & TYPE AS REQUIRED
1	Transfer Hinge	4-WIRE TYPE AS REQUIRED
1	Electrified Lock	F05 (E01-REX, E06) 24VDC
1	Closer	C02011/C02021 (PT4D, PT4H)
1	Floor Stop	L02121 x 3 FASTENERS
1	Sets Self-Adhesive Seals	R0E154

DOOR POSITION SWITCH, POWER, CONDUIT, AND WIRING BY DIVISION 28.  
CARD READER BY DIVISION 28.

EXTERIOR SINGLE SECURITY DOORS

HW-SH-21A

Each DPS Door to Have: NON-RATED

	Hinges	QUANTITY & TYPE AS REQUIRED
1	Latchset (exit only)	F01 (modified less outside trim)
1	Closer	C02011/C02021 (PT4D, PT4F, PT4H)
1	Threshold (outswing door)	J35130 x SILICONE GASKET
1	Door Sweep	R3A415
1	Set Frame Seals	R3E164
1	Drip	R0Y976

DOOR POSITIONS SWITCH BY DIVISION 28

HW-SH-22A

Each DPS Door to Have: NON-RATED

	Hinges	QUANTITY & TYPE AS REQUIRED
1	Exit Device (exit only)	TYPE 1, F01 LESS TRIM
1	Closer	C02011 (PT4D, PT4F, PT4H)
1	Floor Stop	L02121 x CAST PLATE ADAPTER
1	Threshold	J35130 x SILICONE GASKET
1	Door Sweep	R3A415
1	Set Frame Seals	R3E164
1	Drip	R0Y976

DOOR POSITIONS SWITCH BY DIVISION 28

HW-SH-24A

Each AC, EL, REX, DPS Door to Have:NON-RATED

	Hinges	QUANTITY & TYPE AS REQUIRED
1	Transfer Hinge	4-WIRE TYPE AS REQUIRED
1	Electrified Exit Device (Fail Secure)	TYPE 1 (E01-REX, E06) F13 LEVER
1	Key Cylinder	TYPE AS REQUIRED
1	Closer	C02011 (PT4D, PT4F, PT4H)
1	Floor Stop	L02121 x CAST PLATE ADAPTER
1	Threshold	J35130 x SILICONE GASKET
1	Door Sweep	R3A415
1	Set Frame Seals	R3E164
1	Drip	R0Y976

DOOR POSITION SWITCH, POWER, CONDUIT, AND WIRING BY DIVISION 28.

CARD READER BY DIVISION 28.

## EXTERIOR PAIR SECURITY DOORS

HW-SH-30A

Each Pair DPS Doors to Have:NON-RATED

	Hinges	QUANTITY & TYPE AS REQUIRED
1	Exit Device (exit only)	TYPE 2, F01 LESS TRIM
1	Exit Device (night latch)	TYPE 3, F03, LESS TRIM
1	Key Cylinder	TYPE AS REQUIRED
1	Coordinator	TYPE 21A
1	Overlapping Astragal with	R5Y634 x R0E154 x THRU-BOLTS
2	Closer	C02011 (PT4D, PT4H)
2	Floor Stop	L02121 x CAST PLATE ADAPTER
1	Threshold	J35130 x SILICONE GASKET
2	Door Sweep	R3A415
1	Set Frame Seals	R3E164
1	Drip	R0Y976

DOOR POSITIONS SWITCH BY DIVISION 28

## EXTERIOR SPECIAL SECURITY DOORS

HW-SH-41A

Each DPS Roll-up Door to Have:NON-RATED

1	Key Cylinder	TYPE AS REQUIRED
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DOOR POSITIONS SWITCH BY DIVISION 28

BALANCE OF HARDWARE BY SECTION 08 33 00, COILING DOORS AND GRILLES

- - - E N D - - -



**SECTION 08 80 00**

**GLAZING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies glass related glazing materials and accessories. Glazing products specified apply to factory or field glazed items.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Factory glazed by manufacturer in following units:
  - 1. Section 08 51 13, ALUMINUM WINDOWS Fixed.

**1.3 LABELS**

- A. Temporary labels:
  - 1. Provide temporary label on each light of glass identifying manufacturer or brand and glass type, quality and nominal thickness.
  - 2. Label in accordance with NFRC (National Fenestration Rating Council) label requirements.
  - 3. Temporary labels shall remain intact until glass is approved by Resident Engineer.
- B. Permanent labels:
  - 1. Locate in corner for each pane.
  - 2. Label in accordance with ANSI Z97.1 and SGCC (Safety Glass Certification Council) label requirements.
    - a. Tempered glass.

**1.4 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Certificates:
  - 1. Certificate on shading coefficient.
  - 2. Certificate on "R" value when value is specified.

C. Warranty:

1. Submit written guaranty, conforming to General Condition requirements, and to "Warranty of Construction" Article in this Section.

D. Manufacturer's Literature and Data:

1. Glass, each kind required.
2. Insulating glass units.

E. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.5 DELIVERY, STORAGE AND HANDLING**

- A. Delivery: Schedule delivery to coincide with glazing schedules so minimum handling of crates is required. Do not open crates except as required for inspection for shipping damage.
- B. Storage: Store cases according to printed instructions on case, in areas least subject to traffic or falling objects. Keep storage area clean and dry.
- C. Handling: Unpack cases following printed instructions on case. Stack individual windows on edge leaned slightly against upright supports with separators between each.

**1.6 PROJECT CONDITIONS**

- A. Field Measurements: Field measure openings before ordering tempered glass products. Be responsible for proper fit of field measured products.

**1.7 WARRANTY**

- A. Warranty: Conform to terms of "Warranty of Construction", FAR clause 52.246-21. Provide manufacturer's special warranty as follows:
  1. Insulating glass units to remain sealed for 10 years.

**1.8 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American National Standards Institute (ANSI):
  1. Z97.1-04 Safety Glazing Material Used in Building - Safety

Performance Specifications and Methods of Test.

C. American Society for Testing and Materials (ASTM):

1. C1363-05 Thermal Performance of Building Assemblies, by Means of A Hot Box Apparatus
2. C542-05 Lock-Strip Gaskets.
3. C716-06 Installing Lock-Strip Gaskets and Infill Glazing Materials.
4. C794-06 Adhesion-in-Peel of Elastomeric Joint Sealants.
5. C864-05 Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
6. C920-08 Elastomeric Joint Sealants.
7. C964-07 Standard Guide for Lock-Strip Gasket Glazing.
8. C1036-06 Flat Glass.
9. C1048-04 Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
10. C1172-09 Laminated Architectural Flat Glass.
11. C1376-10 Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
12. D635-06 Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastic in a Horizontal Position.
13. D4802-02 Poly (Methyl Methacrylate) Acrylic Plastic Sheet.
14. E84-09 Surface Burning Characteristics of Building Materials.
15. E1300-09 Determining Load Resistance of Glass in Buildings.
16. E2190-08 Insulating Glass Unit

D. Commercial Item Description (CID):

1. A-A-59502 Plastic Sheet, Polycarbonate

E. Code of Federal Regulations (CFR):

1. 16 CFR 1201 Safety Standard for Architectural Glazing Materials; 1977, with 1984 Revision.

F. National Fire Protection Association (NFPA):

1. 80-08 Fire Doors and Windows.

G. National Fenestration Rating Council (NFRC)

H. Safety Glazing Certification Council (SGCC) 2009

1. Certified Products Directory (Issued Semi-Annually).

I. Underwriters Laboratories, Inc. (UL):

1. 752-06 Bullet-Resisting Equipment.

- J. Unified Facilities Criteria (UFC):
  - 1. 4-010-01-2007 DOD Minimum Antiterrorism Standards for Buildings
- K. Glass Association of North America (GANA):
  - 1. Glazing Manual (Latest Edition)
  - 2. Sealant Manual (2008)
- L. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-10 Wind Load Provisions

## **PART 2 - PRODUCTS**

### **2.1 GLASS**

- A. Clear Glass:
  - 1. ASTM C1036, Type I, Class 1, Quality q3.
  - 2. Thickness, 6 mm (1/4 inch).

### **2.2 HEAT-TREATED GLASS**

- A. Clear Tempered Glass:
  - 1. ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality q3.
  - 2. Thickness, 6 mm (1/4 inch).

### **2.3 GLAZING ACCESSORIES**

- A. As required to supplement the accessories provided with the items to be glazed and to provide a complete installation.
- B. Setting Blocks: ASTM C864:
  - 1. Channel shape; having 6 mm (1/4 inch) internal depth.
  - 2. Shore a hardness of 80 to 90 Durometer.
  - 3. Block lengths: 50 mm (two inches) except 100 to 150 mm (four to six inches) for insulating glass.
  - 4. Block width: Approximately 1.6 mm (1/16 inch) less than the full width of the rabbet.
  - 5. Block thickness: Minimum 4.8 mm (3/16 inch). Thickness sized for rabbet depth as required.
- C. Spacers: ASTM C864:
  - 1. Channel shape having a 6 mm (1/4 inch) internal depth.
  - 2. Flanges not less 2.4 mm (3/32 inch) thick and web 3 mm (1/8 inch) thick.
  - 3. Lengths: One to 25 to 76 mm (one to three inches).

4. Shore a hardness of 40 to 50 Durometer.
- D. Glazing Gaskets: ASTM C864:
  1. Firm dense wedge shape for locking in sash.
  2. Soft, closed cell with locking key for sash key.
  3. Flanges may terminate above the glazing-beads or terminate flush with top of beads.
- E. Neoprene, EPDM, or Vinyl Glazing Gasket: ASTM C864.
  1. Channel shape; flanges may terminate above the glazing channel or flush with the top of the channel.
  2. Designed for dry glazing.
- F. Color:
  1. Color of other glazing compounds, gaskets, and sealants which will be exposed in the finished work and unpainted shall be black, gray, or neutral color.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verification of Conditions:
  1. Examine openings for glass and glazing units; determine they are proper size; plumb; square; and level before installation is started.
  2. Verify that glazing openings conform with details, dimensions and tolerances indicated on manufacturer's approved shop drawings.
- B. Advise Contractor of conditions which may adversely affect glass and glazing unit installation, prior to commencement of installation: Do not proceed with installation until unsatisfactory conditions have been corrected.
- C. Verify that wash down of adjacent masonry is completed prior to erection of glass and glazing units to prevent damage to glass and glazing units by cleaning materials.

#### **3.2 PREPARATION**

- A. For sealant glazing, prepare glazing surfaces in accordance with GANA-02 Sealant Manual.
- B. Determine glazing unit size and edge clearances by measuring the actual unit to receive the glazing.
- C. Shop fabricate and cut glass with smooth, straight edges of full size required by openings to provide GANA recommended edge clearances.
- D. Verify that components used are compatible.

- E. Clean and dry glazing surfaces.
- F. Prime surfaces scheduled to receive sealants, as determined by preconstruction sealant- substrate testing.

### **3.3 INSTALLATION - GENERAL**

- A. Install in accordance with GANA-01 Glazing Manual and GANA-02 Sealant Manual unless specified otherwise.
- B. Glaze in accordance with recommendations of glazing and framing manufacturers, and as required to meet the Performance Test Requirements specified in other applicable sections of specifications.
- C. Set glazing without bending, twisting, or forcing of units.
- D. Do not allow glass to rest on or contact any framing member.
- E. Tempered Glass: Install with roller distortions in horizontal position unless otherwise directed.
- F. Transparent (One-Way Vision Glass) Mirror: Use continuous channel glazing gasket.
- G. Insulating Glass Units:
  - 1. Glaze in compliance with glass manufacturer's written instructions.
  - 2. When glazing gaskets are used, they shall be of sufficient size and depth to cover glass seal or metal channel frame completely.
  - 3. Do not use putty or glazing compounds.
  - 4. Do not grind, nip, cut, or otherwise alter edges and corners of fused glass units after shipping from factory.
  - 5. Install with tape or gunnable sealant in wood sash.

### **3.4 INSTALLATION - DRY METHOD (TAPE AND GASKET SPLINE GLAZING)**

- A. Cut glazing spline to length; install on glazing pane. Seal corners by butting and sealing junctions with butyl sealant.
- B. Place setting blocks at 1/3 points with edge block no more than 150 mm (6 inches) from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- D. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Trim protruding tape edge.

### **3.5 INSTALLATION - WET/DRY METHOD (PREFORMED TAPE AND SEALANT)**

- A. Cut glazing tape to length and set against permanent stops, 5 mm (3/16 inch) below sight line. Seal corners by butting tape and dabbing with butyl sealant.
- B. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete the continuity of the air and vapor seal.
- C. Place setting blocks at 1/3 points with edge block no more than 150 mm (6 inches) from corners.
- D. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to achieve full contact at perimeter of pane or glass unit.
- E. Install removable stops, with spacer strips inserted between glazing and applied stops, 6 mm (1/4 inch) below sight line. Place glazing tape on glazing pane or unit with tape flush with sight line.
- F. Fill gap between glazing and stop with sealant to depth equal to bite of frame on glazing, but not more than 9 mm (3/8 inch) below sight line.
- G. Apply cap bead of sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

### **3.6 INSTALLATION - WET METHOD (SEALANT AND SEALANT)**

- A. Place setting blocks at 1/3 points and install glazing pane or unit.
- B. Install removable stops with glazing centered in space by inserting spacer shims both sides at 600 mm (24 inch) intervals, 6 mm (1/4 inch) below sight line.
- C. Fill gaps between glazing and stops with type sealant to depth of bite on glazing, but not more than 9 mm (3/8 inch) below sight line to ensure full contact with glazing and continue the air and vapor seal.
- D. Apply sealant to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

### **3.7 REPLACEMENT AND CLEANING**

- A. Clean new glass surfaces removing temporary labels, paint spots, and defacement after approval by Resident Engineer.
- B. Replace cracked, broken, and imperfect glass, or glass which has been installed improperly.
- C. Leave glass, putty, and other setting material in clean, whole, and acceptable condition.

**3.8 PROTECTION**

- A. Protect finished surfaces from damage during erection, and after completion of work. Strippable plastic coatings on colored anodized finish are not acceptable.

**3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

**3.10 GLAZING SCHEDULE**

- A. Refer to Section 09 06 00, SCHEDULE FOR FINISHES.

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**SECTION 08 90 00**

**LOUVERS AND VENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies fixed wall louvers.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color of finish: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
1. Each type, showing material, finish, size of members, method of assembly, and installation and anchorage details.
- C. Manufacturer's Literature and Data:
1. Each type of louver and vent.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. The Master Painters Institute (MPI):
  - 1. Approved Product List - November 2007
- C. American Society for Testing and Materials (ASTM):
  - 1. A167-99(R2009) Stainless and Heat-Resisting Chromium - Nickel Steel Plate, Sheet, and Strip
  - 2. A1008/A1008M-10 Steel, Sheet, Carbon, Cold Rolled, Structural, and High Strength Low-Alloy with Improved Formability
  - 3. B209/B209M-03(2007) Aluminum and Aluminum Alloy, Sheet and Plate
  - 4. B221-08 Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  - 5. B221M-07 Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire Shapes, and Tubes
- D. National Association of Architectural Metal Manufacturers (NAAMM):
  - 1. AMP 500-506 Metal Finishes Manual
- E. National Fire Protection Association (NFPA):
  - 1. 90A-09 Installation of Air Conditioning and Ventilating Systems
- F. American Architectural Manufacturers Association (AAMA):
  - 1. 2605-11 High Performance Organic Coatings on Architectural Extrusions and Panels
- G. Air Movement and Control Association, Inc. (AMCA):
  - 1. 500-L-07 Testing Louvers

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum, Extruded: ASTM B221/B221M.
- B. Stainless Steel: ASTM A167, Type 302B.
- C. Aluminum, Plate and Sheet: ASTM B209/B209M.
- D. Fasteners: Fasteners for securing louvers and wall vents to adjoining construction, except as otherwise specified or shown, shall be toggle or expansion bolts, of size and type as required for each specific type of installation and service condition.
  - 1. Where type, size, or spacing of fasteners is not shown or specified, submit shop drawings showing proposed fasteners, and method of installation.
  - 2. Fasteners for louvers shall be of stainless steel.

## **2.2 EXTERIOR WALL LOUVERS**

### **A. General:**

1. Provide fixed type louvers of size and design shown.
2. Heads, sills and jamb sections shall have formed caulking slots or be designed to retain caulking. Head sections shall have exterior drip lip, and sill sections an integral water stop.
3. Furnish louvers with sill extension or separate sill as shown.
4. Frame shall be mechanically fastened or welded construction with welds dressed smooth and flush.

### **B. Performance Characteristics:**

1. Weather louvers shall have a minimum of 53.5 percent free area and shall pass 6.35 mm/s (1,250 fpm) free area velocity at a pressure drop not exceeding 0.045 kPa mm (0.18 inch) water gage and carry not more than 3.05 g of water per m<sup>2</sup> (0.01 ounces of water per square foot) of free area for 15 minutes when tested per AMCA Standard 500-L.
2. Louvers shall bear AMCA certified rating seals for air performance and water penetration ratings.

### **C. Aluminum Louvers:**

1. General: Frames, blades, sills and mullions (sliding interlocking type); 2 mm (0.081 inch) thick extruded aluminum. Blades shall be drainable type and have reinforcing bosses.
2. Louvers, fixed: Make frame sizes 13 mm (1/2-inch) smaller than openings. Single louvers frames shall not exceed 1700 mm (66 inches) wide. When openings exceed 1700 mm (66 inches), provide twin louvers separated by mullion members.

## **2.3 LOUVER SCREENS**

- A. Screen Frame: Fabricate from same material as louvers.
- B. Screen: 16 mm by 1 mm (5/8 inch by 0.040 inch) expanded flattened aluminum bird screen.
- C. Fabricate removable screens. Locate screens on inside face of louvers, unless otherwise indicated. Secure to louver frames with machine screws, spaced at each corner and at 12 inches on centers.

## **2.4 CLOSURE ANGLES AND CLOSURE PLATES**

- A. Fabricate from 2 mm (0.074-inch) thick aluminum.
- B. Provide continuous closure angles and closure plates on inside head, jambs and sill of exterior wall louvers.
- C. Secure angles and plates to louver frames with screws, and to concrete with fasteners as specified.

## **2.5 FINISH**

- A. Aluminum Louvers :
  - 1. Organic Finish: AAMA 605 (Fluorocarbon coating).

## **2.6 PROTECTION**

- A. Provide protection for aluminum against galvanic action wherever dissimilar materials are in contact, by painting the contact surfaces of the dissimilar material with a heavy coat of bituminous paint (complete coverage), or by separating the contact surfaces with a performed synthetic rubber tape having pressure sensitive adhesive coating on one side.
- B. Isolate the aluminum from plaster, concrete and masonry by coating aluminum with zinc-chromate primer.
- C. Protect finished surfaces from damage during fabrication, erection, and after completion of the work. Strippable plastic coating on organic finish is not approved.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Set work accurately, in alignment and where shown. Items shall be plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Furnish setting drawings and instructions for installation of anchors and for the positioning of items having anchors to be built into masonry construction. Provide temporary bracing for such items until masonry is set.
- C. Provide anchoring devices and fasteners as shown and as necessary for securing louvers to building construction as specified. Power actuated drive pins may be used, except for removal items and where members would be deformed or substrate damaged by their use.
- D. Generally, set wall louvers in masonry walls during progress of the work. If wall louvers are not delivered to job in time for installation in prepared openings, make provision for later installation. Set in cast-in-place concrete in prepared openings.

### **3.2 CLEANING AND ADJUSTING**

- A. After installation, all exposed prefinished and plated items and all items fabricated from stainless steel and aluminum shall be cleaned as recommended by the manufacturer and protected from damage until completion of the project.
- B. All movable parts, including hardware, shall be cleaned and adjusted to operate as designed without binding or deformation of the members, so as to be centered in the opening of frame, and where applicable, to have all

contact surfaces fit tight and even without forcing or warping the components

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 06 00**

**SCHEDULE FOR FINISHES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section contains a coordinated system in which requirements for materials specified in other sections shown are identified by abbreviated material names and finish codes in the room finish schedule or shown for other locations.

**1.2 MANUFACTURERS**

- A. Manufacturer's trade names and numbers used herein are only to identify colors, finishes, textures and patterns. Products of other manufacturer's equivalent to colors, finishes, textures and patterns of manufacturers listed that meet requirements of technical specifications will be acceptable upon approval in writing by contracting officer for finish requirements.

**1.3 SUBMITTALS**

- A. Submit in accordance with SECTION 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES - provide quadruplicate samples for color approval of materials and finishes specified in this section.
- B. Digital Color Photos - Interior Views: Include a series of photographic slides, representing a sequential walk-through. Show typical public, patient, staff and all specialized areas. The photography is of architectural quality and are the property of the Department of Veterans Affairs, Office of Facility Management.

**1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in text by basic designation only.
- B. MASTER PAINTING INSTITUTE: (MPI)
  - 1. 2001 Architectural Painting Specification Manual

**PART 2 - PRODUCTS**

**2.1 DIVISION 03 - CONCRETE**

A. SECTION 03 47 13, TILT-UP CONCRETE

Finish Color	Texture	Finish	Manufacturer	Mfg. Color Name/No.
Gray	Smooth	Water-Repellent, See Section 07 19 00	To be determined	To be determined

**2.2 DIVISION 04 - MASONRY**

A. SECTION 04 72 10, STONE VENEER WALL

Item	Manufacturer	Mfg. Name/Color/No.
Stone Veneer	Stone Water Quarries	Napa Wallstone; Rhyolite Color: Brown tone to grays and rust
Stone Wall Shop Drawings		
Stone wall Mock up		
Stone Curb mock up		

**2.3 DIVISION 05 - METALS**

A. SECTION 05 12 00, STRUCTURAL STEEL FRAMING

Component	Finish	Color
Structural Steel Framing	Hot-dipped galvanized after fabrication; exterior light industrial coating (100% acrylic latex) over water-based epoxy primer.	Color: P-2 per Section 09 91 00.

B. SECTION 05 50 00, METAL FABRICATION

Item Code	Item	Finish
-	Modular Channel Support Units	Hot-dip Galvanized
-	Mechanical Trench Gratings	Hot-dip Galvanized
-	Aluminum Ladders	Mill Finish
-	Guard Rails/Railings	Hot-dip Galvanized, epoxy primer, exterior light industrial paint finish
-	Pipe Bollards	Galvanized, epoxy primer, exterior light industrial paint finish



## 2.4 DIVISION 06 WOOD, PLASTICS, AND COMPOSITES

### A. SECTION 06 10 00, ROUGH CARPENTRY

Item	Finish	Color
Plywood backing at Electrical/Telecom Rooms	Painted - same color as adjacent walls.	Color P1, see Section 09 91 00, PAINT AND COATINGS.

### B. SECTION 06 62 00 - FINISH CARPENTRY

Item Code	Item	Finish	Color
SS-3	Work Counters	Solid Surfacing	LG Hausys; Hi-Macs Classic; GT910 Egg White

## 2.5 DIVISION 07 - THERMAL AND MOISTURE PROTECTION

### A. SECTION 07 52 16.13, STYRENE-BUTADIENE-STYRENE MODIFIED BITUMINOUS MEMBRANE ROOFING

Item Code	Material	Color	Manufacturer	Mfg. Color Name/No.
RS-1	Cap Sheet	White	Siplast	Paradiene 30 CR FR
	Flashing	White	Siplast	Paradiene 30 CR FR

### B. SECTION 07 71 00, ROOF SPECIALTIES

Item	Material	Manufacturer/Finish
Roof Hatch with lock	Aluminum	Mill finish; Field painted
Roof Hatch Guard Rail	Fiberglass Reinforced Polymer (FRP)	The Bilco Company; Bil-Guard; Color: Safety Yellow

### C. SECTION 07 92 00, JOINT SEALANTS

Location	Color	Manufacturer	Manufacturer Color
Precast Concrete Panels	Match precast concrete	To be determined	To be determined

## 2.6 DIVISION 08 - OPENINGS

### A. SECTION 08 11 13, HOLLOW METAL DOORS AND FRAMES

Component	Color of Paint Type and Gloss
Exterior Doors and Frames	Exterior Light Industrial Coating, MPI Gloss level 3 (LL) Color: TBD

Component	Color of Paint Type and Gloss
Interior Doors and Frame	Interior Light Industrial Coating, MPI Gloss level 3 (LL) Color: TBD

B. SECTION 08 33 00, COILING DOORS AND GRILLES

Location	Item	Material	Finish	Manufacturer	Manufacturer Color Name/No.
Exterior	Door	Galvanized Steel	Powder coated	To be determined	To be determined

C. SECTION 08 51 13, ALUMINUM WINDOWS

Type	Finish	Glazing	Manufacturer	Mfg. Color Name/No.
Fixed	3-coat 70% PVDF	6 mm (1/4") Annealed Float Glass	To be determined	FPC-1, see Section 09 96 54

D. SECTION 08 80 00, GLAZING

Glazing Type	Manufacturer/Description	Mfg. Color Name/No.
G-8		Monolithic Glass - Clear; 6 mm (1/4")
IG-1	-	Monolithic Glass - Clear; 6 mm (1/4")
IG-2	-	Monolithic Glass - Clear, Fully Tempered; 6 mm (1/4")

E. SECTION 08 90 00, LOUVERS AND VENTS

Item Code	Item	Material	Finish	Mfg. Color Name/No.
-	Fixed Louvers	Aluminum	3-Coat 70% PVDF	FPC-1, see Section 09 96 54

2.7 DIVISION 09 - FINISHES

A. SECTION 09 30 13, CERAMIC/PORCELAIN TILING

1. CERAMIC/PORCELAIN TILE		
Finish Code	Manufacturer	Mfg. Color Name/No
PT-33	Daltile	Keystones; Color: Desert Gray Size: 2" x 2" Epoxy grout for floor application, Grout Color: Custom Building Product #165 Delorean Gray

1. CERAMIC/PORCELAIN TILE		
Finish Code	Manufacturer	Mfg. Color Name/No
CT-7	Daltile	Natural Hues; Color: Arctic White Size: 2" x 2" Epoxy grout for floor application, Grout Color: Custom Building Product #381 Bright White

B. SECTION 09 51 00, ACOUSTICAL CEILINGS

Finish Code	Type/ Form/ Pattern	Manufacturer	Mfg No/	Metal Suspension System
AT-5	Type IV, Form 2, Pattern E	Armstrong World Industries, Inc.	Ultima #1912, beveled tegular	Suprafine 9/16"

C. SECTION 09 65 13, RESILIENT BASE AND ACCESSORIES

Finish Code	Item	Height	Manufacturer	Mfg Name/No.
RB-1	Rubber Base (RB)	6"	Johnsonite	Color: 179 Steel

D. SECTION 09 65 16.13, LINOLEUM FLOORING

1. RESILIENT SHEET FLOORING			
Finish Code	Pattern name	Manufacturer	Mfg. Color Name/No.
LN-3	Colorette with NATURcote Linoleum	Armstrong World Industries, Inc.	Colorette with Naturcote Linoleum; Color: LP151 Spider Webs Gauge: 0.100" (2.5mm) Sheet: 2.0 m x 30 m

E. SECTION 09 84 33, SOUND-ABSORBING WALL AND CEILING UNITS

Finish Code	Item	Manufacturer	Mfg. Color Name/No.
AWT-1	Acoustical Wall and Ceiling Panels	Pinta Acoustic, Inc.	SONEX Classic Panel Finish/Color: Natural grey

F. SECTION 09 91 00, PAINTING

1. MPI Gloss and Sheen Standards

		<b>Gloss @60</b>	<b>Sheen @85</b>
Gloss Level 1	A traditional matte finish-flat	Max. 5 units, and	Max 10 units
Gloss Level 2	A high side sheen flat - "a velvet-like" finish	Max 10 units, and	10-35 units
Gloss Level 3	A traditional "egg-shell like" finish	10-25 units, and	10-35 units
Gloss Level 4	A "satin-like" finish	20-35 units, and	Min. 35 units
Gloss Level 5	A traditional semi-gloss	35-70 units	
Gloss Level 6	A traditional gloss	70-85 units	
Gloss Level 7	A high gloss	More than 85 units	

2. Paints			
Paint Code	Gloss	Manufacturer	Mfg. Color Name/No.
P-2	Level 3	Kelly-Moore	KM3933-2 Granite Cliff
P-4	Level 3	Kelly-Moore	OW228-1 Pristine Linen
CS-1 (Walls)	-	-	Use Water Repellent specified in Section 07 19 00
CS-1 (Floors)	-	-	MPI 99
Note: Use P-4 Gloss Level 1 as typical ceiling paint Use P-4 Gloss Level 5 in wet areas Use P-2 Gloss Level 3 as typical door frame and trim paints			

G. SECTION 09 96 54, FLUOROPOLYMER SPECIAL COATING SYSTEM

Finish Code	Item	Manufacturer	Color Pattern/ Name/No.
FPC-1	3-coat 70% PVDF, panel and extrusion coatings	PPG	Duranar Sunstorm Sunlight Silver

## 2.8 DIVISION 10 - SPECIALTIES

### A. SECTION 10 14 00, SIGNAGE

Item	Material	Manufacturer	Mfg. Name/Color/No.
Signage Color C-1	Paint	Kelly Moore	23, Swiss Coffee (white)
Signage Color C-2	Paint	Kelly Moore	KM3846-3 Burnished Pewter (gray)
Signage Color C-3	Paint	Kelly Moore	41, Snip of Tannin (tan)
Signage Wood W-1	Maple Wood Veneer	Same as casegoods	Same as casegoods

### B. SECTION 10 28 00, TOILET, BATH, AND LAUNDRY ACCESSORIES

Item Code	Item	Manufacturer	Color Pattern/ Name/No.
-	Grab Bars	Bobrick, B-6806 Series	Stainless steel No. 4 finish
-	Metal framed mirror	-Bobrick, B-1658	Stainless steel No. 4 finish

## 2.9 DIVISION 12 - FURNISHINGS

### A. SECTION 12 24 00, WINDOW SHADES

Item	Material	Manufacturer/Color Pattern/ Name/No.
Roll Down Shade	Thermoplastic Olefin (TPO) fiber filaments with a TPO coating	MechoShade Ecoveil 1550 Series; Openness factor: 3%; Color: 1569 Silver Birch

### B. SECTION 12 93 00, SITE FURNISHINGS

Item	Material	Manufacturer	Mfg. Name/Color/No.
Bike Rack	Stainless Steel		

## 2.10 DIVISION 23 - HEATING, VENTING, AND AIR-CONDITIONING (HVAC)

### A. SECTION 23 85 00, THERMAL ENERGY STORAGE TANK SYSTEM

Item	Material	Finish	Standard
Thermal Energy Storage Tank Exterior Surface	Steel	Painted - Same color as adjacent emergency water storage tank	Inside Coating System No. 1, AWWA D102. Uninsulated surfaces AWWA D102 ICS-1-S. Insulated surfaces AWWA D102 ICS-1-W.

## 2.11 DIVISION 32 - EXTERIOR IMPROVEMENTS

### A. SECTION 32 05 20 CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

Item	Manufacturer	Mfg. Name/Color/No.
Concrete Paving Mock up		
Color Additives/Pigments	Davis Colors	Color: Pebble 641

### B. SECTION 32 90 00, PLANTING

Item	Material	Manufacturer
Wildflower and erosion control hydroseed mixes		
Organic mulch		
Organic (including composted if used) amendment		
Permeable backfill (filter rock)		
Bioswale mineral content		
Bioswale yard waste compost		
Imported Planting soil		
Bioswale mineral component backfill		
Bioswale yard waste compost		

## PART 3 - EXECUTION

### 3.1 FINISH SCHEDULES & MISCELLANEOUS ABBREVIATIONS

Term	Abbreviation
Acoustical Ceiling	AT
Acoustical Wall and Ceiling Panels	AWT
Carpet Tile	CPT
Concrete Sealer	CS
Ceramic Tile	CT
Fluoropolymer Coating	FPC
Glazing	G
Glazing, Interior	IG
Linoleum (Resilient Sheet Flooring)	LN
Paint	P
Porcelain Tile	PT

Term	Abbreviation
Rubber Base	RB
Roofing System	RS
Solid Surface	SS

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**SECTION 09 22 16**

**NON-STRUCTURAL METAL FRAMING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies steel studs wall systems, ceiling or soffit suspended or furred framing, wall furring, fasteners, and accessories for the screw attachment of gypsum board.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Support for wall mounted items: Section 05 50 00, METAL FABRICATIONS.
- D. Ceiling suspension systems for acoustical tile or panels and lay in gypsum board panels: Section 09 51 00, ACOUSTICAL CEILINGS Section 09 29 00, GYPSUM BOARD.

**1.3 TERMINOLOGY**

- A. Description of terms shall be in accordance with ASTM C754, ASTM C11, ASTM C841 and as specified.
- B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by beams, trusses, or bar joists. In interstitial spaces with walk-on floors the underside of the walk-on floor is the underside of structure overhead.
- C. Thickness of steel specified is the minimum bare (uncoated) steel thickness.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Studs, runners and accessories.
  - 2. Hanger inserts.
  - 3. Channels (Rolled steel).
  - 4. Furring channels.

5. Screws, clips and other fasteners.

C. LEED Submittals: Submit in accordance with Section 01 81 11.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

D. Shop Drawings:

1. Typical ceiling suspension system.
2. Typical metal stud and furring construction system including details around openings and corner details.
3. Typical fire rated assembly details of construction same as that used in fire rating test.

E. Test Results: Fire rating test designation, each fire rating required for each assembly.

#### **1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE**

A. In accordance with the requirements of ASTM C754.

#### **1.6 APPLICABLE PUBLICATIONS**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society For Testing And Materials (ASTM)

1. A123-09 Zinc (Hot-dip Galvanized) Coatings on Iron and Steel Products
2. A653/A653M-09 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
3. A641-09 Zinc-Coated (Galvanized) Carbon Steel Wire
4. C11-10 Terminology Relating to Gypsum and Related Building Materials and Systems
5. C635-07 Manufacture, Performance, and Testing of Metal Suspension System for Acoustical Tile and Lay-in Panel Ceilings
6. C636-06 Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
7. C645-09 Non-Structural Steel Framing Members
8. C754-09 Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

9. C841-03 (R2008) Installation of Interior Lathing and Furring
10. C954-07 Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
11. C1002-07 Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
12. E580-09 Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint.

## **PART 2 - PRODUCTS**

### **2.1 PROTECTIVE COATING**

- A. Galvanize steel studs, runners (track), rigid (hat section) furring channels, "Z" shaped furring channels, and resilient furring channels, with coating designation of G-60 minimum, per ASTM 123.

### **2.2 STEEL STUDS AND RUNNERS (TRACK)**

- A. ASTM C645, modified for thickness specified and sizes as shown.
  1. Use ASTM A525 steel, 0.8 mm (0.0329-inch) thick bare metal (33 mil).
  2. Runners same thickness as studs.
- B. Studs 3600 mm (12 feet) or less in length shall be in one piece.

### **2.3 FURRING CHANNELS**

- A. Rigid furring channels (hat shape): ASTM C645.
- B. "Z" Furring Channels:
  1. Not less than 0.45 mm (0.0179-inch)-thick bare metal, with 32 mm (1-1/4 inch) and 19 mm (3/4-inch) flanges.
  2. Web furring depth to suit thickness of insulation with slotted perforations.
- C. Rolled Steel Channels: ASTM C754, cold rolled; or, ASTM C841, cold rolled.

### **2.4 FASTENERS, CLIPS, AND OTHER METAL ACCESSORIES**

- A. ASTM C754, except as otherwise specified.
- B. For fire rated construction: Type and size same as used in fire rating test.
- C. Fasteners for steel studs thicker than 0.84 mm (0.033-inch) thick. Use ASTM C954 steel drill screws of size and type recommended by the manufacturer of the material being fastened.

D. Tie Wire and Hanger Wire:

1. ASTM A641, soft temper, Class 1 coating.
2. Gage (diameter) as specified in ASTM C754 or ASTM C841.

E. Attachments for Wall Furring:

1. Manufacturers standard items fabricated from zinc-coated (galvanized) steel sheet.
2. For concrete walls: Metal slots with adjustable inserts or adjustable wall furring brackets. Spacers may be fabricated from 1 mm (0.0396-inch) thick galvanized steel with corrugated edges.

F. Power Actuated Fasteners: Type and size as recommended by the manufacturer of the material being fastened.

**2.5 SUSPENDED CEILING SYSTEM FOR GYPSUM BOARD (OPTION)**

- A. Conform to ASTM C635, heavy duty, with not less than 35 mm (1-3/8 inch) wide knurled capped flange face designed for screw attachment of gypsum board.
- B. Wall track channel with 35 mm (1-3/8 inch) wide flange.

**PART 3 - EXECUTION**

**3.1 INSTALLATION CRITERIA**

- A. Where fire rated construction is required for walls, partitions, columns, beams and floor-ceiling assemblies, the construction shall be same as that used in fire rating test.
- B. Construction requirements for fire rated assemblies and materials shall be as shown and specified, the provisions of the Scope paragraph (1.2) of ASTM C754 and ASTM C841 regarding details of construction shall not apply.

**3.2 INSTALLING STUDS**

- A. Install studs in accordance with ASTM C754, except as otherwise shown or specified.
- B. Cut studs 6 mm to 9 mm (1/4 to 3/8-inch) less than floor to underside of structure overhead when extended to underside of structure overhead.
- C. Where studs are shown to terminate above suspended ceilings, provide bracing as shown or extend studs to underside of structure overhead.
- D. Extend studs to underside of structure overhead for fire, rated partitions, smoke partitions, shafts, and sound rated partitions .
- E. At existing plaster ceilings and where shown, studs may terminate at ceiling as shown.

F. Openings:

1. Frame jambs of openings in stud partitions and furring with two studs placed back to back or as shown.
2. Fasten back to back studs together with 9 mm (3/8-inch) long Type S pan head screws at not less than 600 mm (two feet) on center, staggered along webs.
3. Studs fastened flange to flange shall have splice plates on both sides approximately 50 X 75 mm (2 by 3 inches) screwed to each stud with two screws in each stud.

G. Fastening Studs:

1. Fasten studs located adjacent to partition intersections, corners and studs at jambs of openings to flange of runner tracks with two screws through each end of each stud and flange of runner.
2. Do not fasten studs to top runner track when studs extend to underside of structure overhead.

H. Chase Wall Partitions:

1. Locate cross braces for chase wall partitions to permit the installation of pipes, conduits, carriers and similar items.
2. Use studs or runners as cross bracing not less than 63 mm (2-1/2 inches wide).

I. Form building seismic or expansion joints with double studs back to back spaced 75 mm (three inches) apart plus the width of the seismic or expansion joint.

J. Form control joint, with double studs spaced 13 mm (1/2-inch) apart.

**3.3 INSTALLING WALL FURRING FOR FINISH APPLIED TO ONE SIDE ONLY**

A. In accordance with ASTM C754, or ASTM C841 except as otherwise specified or shown.

B. Wall furring-Stud System:

1. Brace as specified in ASTM C754 for Wall Furring-Stud System or brace with sections or runners or studs placed horizontally at not less than three foot vertical intervals on side without finish.
2. Securely fasten braces to each stud with two Type S pan head screws at each bearing.

C. Installing Wall Furring-Bracket System: Space furring channels not more than 400 mm (16 inches) on center.

**3.4 INSTALLING SUPPORTS REQUIRED BY OTHER TRADES**

A. Provide for attachment and support of electrical outlets, plumbing, laboratory or heating fixtures, recessed type plumbing fixture accessories, access panel frames, wall bumpers, wood seats, toilet stall partitions, dressing booth partitions, urinal screens, chalkboards,

tackboards, wall-hung casework, handrail brackets, recessed fire extinguisher cabinets and other items like auto door buttons and auto door operators supported by stud construction.

- B. Provide additional studs where required. Install metal backing plates, or special metal shapes as required, securely fastened to metal studs.

### **3.5 INSTALLING FURRED AND SUSPENDED CEILINGS OR SOFFITS**

- A. Install furred and suspended ceilings or soffits in accordance with ASTM C754 or ASTM C841 except as otherwise specified or shown for screw attached gypsum board ceilings and for plaster ceilings or soffits.
- B. Concrete slabs on steel decking composite construction:
  - 1. Use pull down tabs when available.
  - 2. Use power activated fasteners when direct attachment to structural framing can not be accomplished.
- C. Where bar joists or beams are more than 1200 mm (48 inches) apart, provide intermediate hangers so that spacing between supports does not exceed 1200 mm (48 inches). Use clips, bolts, or wire ties for direct attachment to steel framing.
- D. Installing suspended ceiling system for gypsum board (ASTM C635 Option):
  - 1. Install only for ceilings to receive screw attached gypsum board.
  - 2. Install in accordance with ASTM C636.
    - a. Install main runners spaced 1200 mm (48 inches) on center.
    - b. Install 1200 mm (four foot) tees not over 600 mm (24 inches) on center; locate for edge support of gypsum board.
    - c. Install wall track channel at perimeter.

### **3.6 TOLERANCES**

- A. Fastening surface for application of subsequent materials shall not vary more than 3 mm (1/8-inch) from the layout line.
- B. Plumb and align vertical members within 3 mm (1/8-inch.)
- C. Level or align ceilings within 3 mm (1/8-inch.)

### **3.7 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 29 00**

**GYPSUM BOARD**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies installation and finishing of gypsum board.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Installation of steel framing members for walls, partitions, furring, soffits, and ceilings: Section 05 40 00, COLD-FORMED METAL FRAMING, and Section 09 22 16, NON- STRUCTURAL METAL FRAMING.
- D. Acoustical Sealants: Section 07 92 00, JOINT SEALANTS.

**1.3 TERMINOLOGY**

- A. Definitions and description of terms shall be in accordance with ASTM C11, C840, and as specified.
- B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by the trusses or bar joists.
- C. "Yoked": Gypsum board cut out for opening with no joint at the opening (along door jamb or above the door).

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Cornerbead and edge trim.
  - 2. Finishing materials.
  - 3. Laminating adhesive.
  - 4. Gypsum board, each type.

- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Shop Drawings:
  - 1. Typical gypsum board installation, showing corner details, edge trim details and the like.
  - 2. Typical fire rated assembly, indicating details of construction same as that used in fire rating test.
- E. Samples:
  - 1. Cornerbead.
  - 2. Edge trim.
  - 3. Control joints.

#### **1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE**

- A. In accordance with the requirements of ASTM C840.

#### **1.6 ENVIRONMENTAL CONDITIONS**

- A. In accordance with the requirements of ASTM C840 or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing And Materials (ASTM):
  - 1. C11-08 Terminology Relating to Gypsum and Related Building Materials and Systems
  - 2. C475-02 Joint Compound and Joint Tape for Finishing Gypsum Board
  - 3. C840-08 Application and Finishing of Gypsum Board



4. C919-08 Sealants in Acoustical Applications
  5. C954-07 Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Stud from 0.033 in. (0.84mm) to 0.112 in. (2.84 mm) in thickness
  6. C1002-07 Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
  7. C1047-05 Accessories for Gypsum Wallboard and Gypsum Veneer Base
  8. C1177-06 Glass Mat Gypsum Substrate for Use as Sheathing
  9. C1658-06 Glass Mat Gypsum Panels
  10. C1396-06 Gypsum Board
  11. E84-08 Surface Burning Characteristics of Building Materials
- C. Underwriters Laboratories Inc. (UL):
1. Latest Edition Fire Resistance Directory
- D. Inchcape Testing Services (ITS):
1. Latest Editions Certification Listings

## **PART 2 - PRODUCTS**

### **2.1 GYPSUM BOARD**

- A. Gypsum Board: ASTM C1396, Type X, 16 mm (5/8 inch) thick unless shown otherwise. Shall contain a minimum of 20 percent recycled gypsum.
- B. Water Resistant Gypsum Backing Board: ASTM C620, Type X, 16 mm (5/8 inch) thick.
- C. Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
  1. Core: 5/8 inch (15.9 mm), Type X.
  2. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- D. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 1; Type X, 16 mm (5/8 inch) thick.
  1. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- E. Paper facings shall contain 100 percent post-consumer recycled paper content.

## **2.2 ACCESSORIES**

- A. ASTM C1047, except form of 0.39 mm (0.015 inch) thick zinc coated steel sheet.
- B. Flanges not less than 22 mm (7/8 inch) wide with punchouts or deformations as required to provide compound bond.

## **2.3 FASTENERS**

- A. ASTM C1002 and ASTM C840, except as otherwise specified.
- B. ASTM C954, for steel studs thicker than 0.04 mm (0.33 inch).
- C. Select screws of size and type recommended by the manufacturer of the material being fastened.
- D. For fire rated construction, type and size same as used in fire rating test.

## **2.4 FINISHING MATERIALS AND LAMINATING ADHESIVE**

- A. ASTM C475 and ASTM C840. Free of antifreeze, vinyl adhesives, preservatives, biocides and other VOC. Adhesive shall contain a maximum VOC content of 50 g/l.

# **PART 3 - EXECUTION**

## **3.1 INSTALLING GYPSUM BOARD**

- A. Coordinate installation of gypsum board with other trades and related work.
- B. Install gypsum board in accordance with ASTM C840, except as otherwise specified.
- C. Moisture and Mold-Resistant Assemblies: Provide and install moisture and mold-resistant glass mat gypsum wallboard products with moisture-resistant surfaces complying with ASTM C1658 where shown and in locations which might be subject to moisture exposure during construction.
- D. Use gypsum boards in maximum practical lengths to minimize number of end joints.
- E. Bring gypsum board into contact, but do not force into place.
- F. Ceilings:
  - 1. For single-ply construction, use perpendicular application.
- G. Walls:
  - 1. When gypsum board is installed parallel to framing members, space fasteners 300 mm (12 inches) on center in field of the board, and 200 mm (8 inches) on center along edges.

2. When gypsum board is installed perpendicular to framing members, space fasteners 300 mm (12 inches) on center in field and along edges.
3. Stagger screws on abutting edges or ends.
4. For single-ply construction, apply gypsum board with long dimension either parallel or perpendicular to framing members as required to minimize number of joints except gypsum board shall be applied vertically over "Z" furring channels.
5. Control Joints ASTM C840 and as follows:
  - a. Locate at both side jambs of openings if gypsum board is not "yoked". Use one system throughout.
  - b. Not required for wall lengths less than 9000 mm (30 feet).
  - c. Extend control joints the full height of the wall or length of soffit/ceiling membrane.

H. Electrical and Telecommunications Boxes:

1. Seal annular spaces between electrical and telecommunications receptacle boxes and gypsum board partitions.

I. Accessories:

1. Set accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified.
2. Install in one piece, without the limits of the longest commercially available lengths.
3. Corner Beads:
  - a. Install at all vertical and horizontal external corners and where shown.
  - b. Use screws only. Do not use crimping tool.
4. Edge Trim (casings Beads):
  - a. At both sides of expansion and control joints unless shown otherwise.
  - b. Where gypsum board terminates against dissimilar materials and at perimeter of openings, except where covered by flanges, casings or permanently built-in equipment.
  - c. Where gypsum board surfaces of non-load bearing assemblies abut load bearing members.
  - d. Where shown.

### **3.2 FINISHING OF GYPSUM BOARD**

- A. Finish joints, edges, corners, and fastener heads in accordance with ASTM C840. Use Level 4 finish for all finished areas unless otherwise noted.
- B. Before proceeding with installation of finishing materials, assure the following:
  1. Gypsum board is fastened and held close to framing or furring.

2. Fastening heads in gypsum board are slightly below surface in dimple formed by driving tool.

- C. Finish joints, fasteners, and all openings, including openings around penetrations, on that part of the gypsum board extending above suspended ceilings to seal surface of non decorated fire rated gypsum board construction. After the installation of hanger rods, hanger wires, supports, equipment, conduits, piping and similar work, seal remaining openings and maintain the integrity of the fire rated construction/ Sanding is not required of non decorated surfaces.

### **3.3 REPAIRS**

- A. After taping and finishing has been completed, and before decoration, repair all damaged and defective work, including nondecorated surfaces.
- B. Patch holes or openings 13 mm (1/2 inch) or less in diameter, or equivalent size, with a setting type finishing compound or patching plaster.
- C. Repair holes or openings over 13 mm (1/2 inch) diameter, or equivalent size, with 16 mm (5/8 inch thick gypsum board secured in such a manner as to provide solid substrate equivalent to undamaged surface.
- D. Tape and refinish scratched, abraded or damaged finish surfaces including cracks and joints in non decorated surface to provide fire protection equivalent to the fire rated construction.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 30 13**

**CERAMIC/PORCELAIN TILING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies porcelain tiles.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Sealing of joints where specified: Section 07 92 00, JOINT SEALANTS.
- D. Color, texture and pattern of field tile and trim shapes, size of field tile, and color of grout specified: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
1. Porcelain tile, each type, color, patterns and size.
- C. Product Data:
1. Porcelain tile, marked to show each type, size, and shape required.
  2. Leveling compound.
  3. Latex-Portland cement mortar and grout.
  4. Epoxy grout.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## E. Certification:

1. Master grade, ANSI A137.1.

**1.4 DELIVERY AND STORAGE**

- A. Deliver materials in containers with labels legible and intact and grade-seals unbroken.
- B. Store material to prevent damage or contamination.

**1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in text by basic designation only.

## B. American National Standards Institute (ANSI):

1. A10.20-05 Safety Requirements for Ceramic Tile, Terrazzo, and Marble Works
2. A108.1A-05 Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar
3. A108.1B-05 Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with dry-Set or latex-Portland Cement Mortar
4. A108.1C-05 Contractors Option; Installation of Ceramic Tile in the Wet-Set method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar
5. A108.4-05 Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesives
6. A108.5-05 Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar
7. A108.6-05 Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy
8. A108.8-05 Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout
9. A108.10-05 Installation of Grout in Tilework
10. A108.11-05 Interior Installation of Cementitious Backer Units
11. A108.13-05 Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone
12. A118.1-05 Dry-Set Portland Cement Mortar
13. A118.3-05 Chemical Resistant, Water Cleanable Tile-Setting Epoxy and Water Cleanable Tile-Setting and Grouting Epoxy Adhesive
14. A118.5-05 Chemical Resistant Furan Mortars and Grouts for Tile Installation
15. A118.6-05 Standard Cement Grouts for Tile Installation
16. A118.10-05 Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation

17. A137.1-88 Ceramic Tile

C. American Society For Testing And Materials (ASTM):

1. A185-07 Steel Welded Wire Fabric, Plain, for Concrete Reinforcing
2. C109/C109M-07 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch. or (50-mm) Cube Specimens)
3. C241-90 (R2005) Abrasion Resistance of Stone Subjected to Foot Traffic
4. C348-02 Standard Test Method for Flexural Strength of Hydraulic- Cement Mortars
5. C627-93(R2007) Evaluating Ceramic Floor Tile Installation Systems Using the Robinson-Type Floor Tester
6. C954-07 Steel Drill Screws for the Application of Gypsum Board on Metal Plaster Base to Steel Studs from 0.033 in (0.84 mm) to 0.112 in (2.84 in thickness)
7. C979-05 Pigments for Integrally Colored Concrete
8. C1002-07 Steel Self-Piercing Tapping Screws for the Application of Panel Products
9. C1027-99(R2004) Determining "Visible Abrasion Resistance on Glazed Ceramic Tile"
10. C1028-07 Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull Meter Method
11. C1127-01 Standard Guide for Use of High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane with an Integral Wearing Surface
12. D4397-02 Standard Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
13. D5109-99(R2004) Standard Test Methods for Copper-Clad Thermosetting Laminates for Printed Wiring Boards

D. Marble Institute of America (MIA):

1. Design Manual III-2007

E. Tile Council of North America, Inc. (TCNA):

1. 2011 Handbook for Ceramic, Glass, and Tile Installation

## **PART 2 - PRODUCTS**

### **2.1 TILE**

A. Comply with ANSI A137.1, Standard Grade, except as modified:

1. Inspection procedures listed under the Appendix of ANSI A137.1.

2. Abrasion Resistance Classification:
    - a. Tested in accordance with values listed in Table 1, ASTM C 1027.
    - b. Class IV, 6000 revolutions.
  3. Slip Resistant Tile for Floors:
    - a. Coefficient of friction, when tested in accordance with ASTM C1028, required for level of performance:
      - 1) Not less than 0.6, for wet and dry conditions for other areas.
  4. Factory Blending: For tile with color variations, within the ranges selected during sample submittals blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.
  5. Factory-Applied Temporary Protective Coating:
    - a. Protect exposed face surfaces (top surface) of tile against adherence of mortar and grout by pre-coating with a continuous film of petroleum paraffin wax, applied hot.
    - b. Do not coat unexposed tile surfaces.
- B. Porcelain Tile: Nominal 8 mm (5/16 inch) thick, with cushion edges. Porcelain tile produced by the dust pressed method shall be made of approximately 50% feldspar; the remaining 50% shall be made up of various high-quality light firing ball clays yielding a tile with a water absorption rate of 0.5% or less and a breaking strength of between 390 to 400 pounds.
- C. Trim Shapes:
1. Conform to applicable requirements of adjoining floor and wall tile.
  2. Use trim shapes sizes conforming to size of adjoining field wall tile.
- 2.2 GLASS MAT WATER RESISTANT GYPSUM BACKER BOARD**
- A. Conform to ASTM C1178/C1178M.
- 2.3 SETTING MATERIALS OR BOND COATS**
- A. Conform to TCNA Handbook for Ceramic Tile Installation.
- B. Latex-Portland Cement Mortar: ANSI A118.4.
1. For wall applications, provide non-sagging, latex-Portland cement mortar complying with ANSI A118.4.
- 2.4 GROUTING MATERIALS**
- A. Latex-Portland Cement Grout: ANSI A118.6 color as specified.
1. Sanded grout mixture for joints 3.2 mm (1/8 inch) and wider.
- B. Epoxy Grout:
1. ANSI A118.3.



- C. Grout Sealer: Manufacturer's standard product for sealing cementitious grout joints and that does not change color or appearance of grout.

## **2.5 PATCHING AND LEVELING COMPOUND**

- A. Portland cement base, polymer-modified, self-leveling compound, manufactured specifically for resurfacing and leveling concrete floors. Products containing gypsum are not acceptable.
- B. Shall have minimum following physical properties:
  - 1. Compressive strength - 25 MPa (3500 psig) per ASTM C109/C109M.
  - 2. Flexural strength - 7 MPa (1000 psig) per ASTM C348 (28 day value).
  - 3. Tensile strength - 600 psi per ANSI 118.7.
- C. Capable of being applied in layers up to 38 mm (1-1/2 inches) thick without fillers and up to 100 mm (four inches) thick with fillers, being brought to a feather edge, and being trowelled to a smooth finish.
- D. Primers, fillers, and reinforcement as required by manufacturer for application and substrate condition.
- E. Ready for use in 48 hours after application.

## **2.6 WATER**

- A. Clean, potable and free from salts and other injurious elements to mortar and grout materials.

## **2.7 CLEANING COMPOUNDS**

- A. Specifically designed for cleaning masonry and concrete and which will not prevent bond of subsequent tile setting materials including patching and leveling compounds and elastomeric waterproofing membrane and coat.
- B. Materials containing acid or caustic material not acceptable.

# **PART 3 - EXECUTION**

## **3.1 ENVIRONMENTAL REQUIREMENTS**

- A. Maintain ambient temperature of work areas at not less than 16 degree C (60 degrees F), without interruption, for not less than 24 hours before installation and not less than three days after installation.
- B. Maintain higher temperatures for a longer period of time where required by manufacturer's recommendation and ANSI Specifications for installation.
- C. Do not install tile when the temperature is above 38 degrees C (100 degrees F).

- D. Do not install materials when the temperature of the substrate is below 16 degrees C (60 degrees F).
- E. Do not allow temperature to fall below 10 degrees C (50 degrees F) after fourth day of completion of tile work.

### **3.2 ALLOWABLE TOLERANCE**

- A. Variation in plane of sub-floor, including concrete fills leveling compounds and mortar beds:
  - 1. Not more than 1 in 1000 (1/8 inch in 10 feet) where dry-set Portland cement, and latex-Portland cement mortar setting beds and chemical-resistant bond coats are used.
- B. Variation in Plane of Wall Surfaces:
  - 1. Not more than 1 in 800 (1/8 inch in eight feet) where dry-set or latex-Portland cement mortar is used.

### **3.3 SURFACE PREPARATION**

- A. Cleaning New Concrete:
  - 1. Chip out loose material, clean off all oil, grease dirt, adhesives, curing compounds, and other deterrents to bonding by mechanical method, or by using products specifically designed for cleaning concrete and masonry.
  - 2. Use self-contained power blast cleaning systems to remove curing compounds and steel trowel finish from concrete slabs where ceramic tile will be installed directly on concrete surface with thin-set materials.
  - 3. Steam cleaning or the use of acids and solvents for cleaning will not be permitted.
- B. Patching and Leveling:
  - 1. Mix and apply patching and leveling compound in accordance with manufacturer's instructions.
  - 2. Fill holes and cracks and align concrete floors that are out of required plane with patching and leveling compound.
    - a. Thickness of compound as required to bring finish tile system to elevation shown.
    - b. Float finish.
  - 3. Apply leveling coats of material compatible with wall surface and tile setting material to wall surfaces, other than concrete and masonry that are out of required plane.
- C. Walls:
  - 1. Apply leveling coats of material compatible with wall surface and tile setting material to wall surfaces, other than concrete and masonry that are out of required plane.

### **3.4 CERAMIC TILE - GENERAL**

- A. Comply with ANSI A108 series of tile installation standards in "Specifications for Installation of Ceramic Tile" applicable to methods of installation.
- B. Comply with TCA Installation Guidelines:
- C. Concrete Subfloor Thin-set Mortar : Install per TCA F113.
  - 1. Thin-set Mortar: Latex-portland cement mortar.
- D. Gypsum Board Wall Substrate: Install per TCA W243.
  - 1. Thin-set Mortar: Latex-portland cement mortar.
- E. Workmanship:
  - 1. Lay out tile work so that no tile less than one-half full size is used. Make all cuts on the outer edge of the field.
  - 2. Set tile firmly in place with finish surfaces in true planes. Align tile flush with adjacent tile unless shown otherwise.
  - 3. Form intersections and returns accurately.
  - 4. Cut and drill tile neatly without marring surface.
  - 5. Cut edges of tile abutting penetrations, finish, or built-in items:
    - a. Fit tile closely around electrical outlets, piping, fixtures and fittings, so that plates, escutcheons, collars and flanges will overlap cut edge of tile.
    - b. Seal tile joints water tight as specified in Section 07 92 00, JOINT SEALANTS, around electrical outlets, piping fixtures and fittings before cover plates and escutcheons are set in place.
  - 6. Completed work shall be free from hollow sounding areas and loose, cracked or defective tile.
  - 7. Remove and reset tiles that are out of plane or misaligned.
  - 8. Walls:
    - a. Finish reveals of openings with tile, except where other finish materials are shown or specified.
  - 9. Joints:
    - a. Keep all joints in line, straight, level, perpendicular and of even width unless shown otherwise.
    - b. Make joints in Paver tile, porcelain tile; maximum 3 mm (1/8 inch) wide.

### **3.5 GROUTING**

- A. Grout Type and Location:
  - 1. Grout for floor tiles: Epoxy grout.
  - 2. Grout for wall tiles: Sanded latex portland cement grout.

3. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer from tile faces by wiping with soft cloth.

B. Workmanship:

1. Install and cure grout in accordance with the applicable standard.
2. Portland Cement grout: ANSI A108.10.
3. Epoxy Grout: ANSI A108.6.

**3.6 MOVEMENT JOINTS**

- A. TCA details EJ 171-02.

**3.7 CLEANING**

- A. Thoroughly sponge and wash tile. Polish glazed surfaces with clean dry cloths.
- B. Methods and materials used shall not damage or impair appearance of tile surfaces.
- C. The use of acid or acid cleaners on glazed tile surfaces is prohibited.
- D. Clean tile grouted with epoxy, furan and commercial Portland cement grout and tile set in elastomeric bond coat as recommended by the manufacturer of the grout and bond coat.

**3.8 PROTECTION**

- A. Keep traffic off tile floor, until grout and setting material is firmly set and cured.

**3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 51 00**

**ACOUSTICAL CEILINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Metal ceiling suspension system for acoustical ceilings.
- B. Acoustical units.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color, pattern, and location of each type of acoustical unit:
  - 1. Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 QUALITY CONTROL**

- A. Seismic Design:
  - 1. Design suspension system for seismic considerations under direct supervision of Professional Structural Engineer experienced in design of this work and licensed in state of California.
  - 2. Design in accordance with ASCE/SEI 7 and VA H-18-8, Seismic Design Requirements. Refer to Structural Drawings, Sheet SS0.1.1, for Seismic Design Criteria.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
  - 1. Acoustical units, each type, with label indicating conformance to specification requirements, including units specified to match existing.
  - 2. Colored markers for units providing access.
- C. Manufacturer's Literature and Data:
  - 1. Ceiling suspension system, each type, showing complete details of installation.
  - 2. Acoustical units, each type

- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- E. Manufacturer's Certificates: Acoustical units, each type, in accordance with specification requirements.

## **1.5 DEFINITIONS**

- A. Standard definitions as defined in ASTM C634.
- B. Terminology as defined in ASTM E1264.

## **1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A641/A641M-03 Zinc-coated (Galvanized) Carbon Steel Wire
  2. A653/A653M-07 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip Process
  3. C423-07 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
  4. C634-02 (E2007) Standard Terminology Relating to Environmental Acoustics
  5. C635-04 Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
  6. C636-06 Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
  7. E84-07 Surface Burning Characteristics of Building Materials
  8. E119-07 Fire Tests of Building Construction and Materials
  9. E413-04 Classification for Rating Sound Insulation.
  10. E580/E580M-11B Installation of Ceiling Suspension System for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.
  11. E1264-(R2005) Classification for Acoustical Ceiling Products
- C. Ceilings and Interior Systems Construction Association (CISCA)

1. Ceiling Systems Handbook.

## **PART 2 - PRODUCTS**

### **2.1 METAL SUSPENSION SYSTEM**

- A. ASTM C635, heavy-duty system, except as otherwise specified.
  1. Ceiling suspension system members may be fabricated from either of the following unless specified otherwise.
    - a. Galvanized cold-rolled steel, bonderized.
  2. Use same construction for cross runners as main runners. Use of lighter-duty sections for cross runners is not acceptable.
- B. Exposed grid suspension system for support of lay-in panels:
  1. Exposed grid width not less than 14 mm (9/16 inch) with not less than 7 mm (9/32 inch) panel bearing surface.
  2. Fabricate wall molding and other special molding from the same material with same exposed width and finish as the exposed grid members.
  3. On exposed metal surfaces apply baked-on enamel flat texture finish in color to match adjacent acoustical units unless specified otherwise in Section 09 06 00, SCHEDULE FOR FINISHES.

### **2.2 WIRE**

- A. ASTM A641.
- B. For wire hangers: Minimum diameter 2.68 mm (0.1055 inch).
- C. For bracing wires: Minimum diameter 3.43 mm (0.1350 inch).

### **2.3 ANCHORS AND INSERTS**

- A. Use anchors or inserts to support twice the loads imposed by hangers attached thereto.
- B. Clips:
  1. Galvanized steel.
  2. Designed to clamp to steel beam or bar joists, or secure framing member together.
  3. Designed to rigidly secure framing members together.
  4. Designed to sustain twice the loads imposed by hangers or items supported.

### **2.4 CARRYING CHANNELS FOR SECONDARY FRAMING**

- A. Fabricate from cold-rolled or hot-rolled steel, black asphaltic paint finish, free of rust.

B. Weighing not less than the following, per 300 m (per thousand linear feet):

Size mm	Size Inches	Cold-rolled Kg      Pound	Hot-rolled Kg      Pound
38	1 1/2	215.4    475	508      1120
50	2	267.6    590	571.5    1260

## 2.5 ACOUSTICAL UNITS

A. General:

1. ASTM E1264, weighing 3.6 kg/m<sup>2</sup> (3/4 psf) minimum for mineral fiber panels or tile.
2. Class A Flame Spread: ASTM 84
3. Minimum NRC (Noise Reduction Coefficient): 0.70 unless specified otherwise: ASTM C423.
4. Minimum CAC (Ceiling Attenuation Class): 35 unless specified otherwise: ASTM E413.
5. Manufacturers standard finish, minimum Light Reflectance (LR) coefficient of 0.90 on the exposed surfaces, except as specified otherwise in Section 09 06 00, SCHEDULE FOR FINISHES.
6. Lay-in panels: Sizes as shown, with beveled reveal edges.

B. Type IV Units - Mineral base with membrane-faced overlay, Form 2 - Water felted, minimum 16 mm (5/8 inch) thick. Apply over the paint coat on the face of the unit a poly (vinyl) chloride overspray having a flame spread index of 25 or less when tested in accordance with ASTM E84.

## 2.6 ACCESS IDENTIFICATION

A. Markers:

1. Use colored markers with pressure sensitive adhesive on one side.
2. Make colored markers of paper or plastic, 6 to 9 mm (1/4 to 3/8 inch) in diameter.

B. Use markers of the same diameter throughout building.

C. Color Code: Use following color markers for service identification:

Color	Service
Red	Sprinkler System: Valves and Controls
Green	Domestic Water: Valves and Controls
Yellow	Chilled Water and Heating Water
Blue	Ductwork: Dampers and Controls



### **PART 3 - EXECUTION**

#### **3.1 CEILING TREATMENT**

- A. Treatment of ceilings shall include sides and soffits of ceiling beams, furred work 600 mm (24 inches) wide and over, and vertical surfaces at changes in ceiling heights unless otherwise shown. Install acoustic tiles after wet finishes have been installed and solvents have cured.
- B. Lay out acoustical units symmetrically about center lines of each room or space unless shown otherwise on reflected ceiling plan.
- C. Moldings:
  - 1. Install metal wall molding at perimeter of room, column, or edge at vertical surfaces.
  - 2. Install special shaped molding at changes in ceiling heights and at other breaks in ceiling construction to support acoustical units and to conceal their edges.

#### **3.2 CEILING SUSPENSION SYSTEM INSTALLATION**

- A. General:
  - 1. Install metal suspension system for acoustical tile and lay-in panels in accordance with ASTM C636 and ASTM E580/E580M, except as specified otherwise.
  - 2. Use direct or indirect hung suspension system or combination thereof as defined in ASTM C635.
  - 3. Support a maximum area of 1.48 m<sup>2</sup> (16 sf) of ceiling per hanger.
  - 4. Prevent deflection in excess of 1/360 of span of cross runner and main runner.
  - 5. Provide extra hangers, minimum of one hanger at each corner of each item of mechanical, electrical and miscellaneous equipment supported by ceiling suspension system not having separate support or hangers.
  - 6. Provide not less than 100 mm (4 inch) clearance from the exposed face of the acoustical units to the underside of ducts, pipe, conduit, secondary suspension channels, concrete beams or joists; and steel beam or bar joist unless furred system is shown,
  - 7. Use main runners not less than 1200 mm (48 inches) in length.
  - 8. Install hanger wires vertically. Angled wires are not acceptable except for seismic restraint bracing wires.
- B. Anchorage to Structure:
  - 1. Composite Concrete Deck:
    - a. Install hanger inserts and wire loops required for support of hanger and bracing wire in concrete forms before concrete is placed. Install hanger wires with looped ends through steel deck if steel deck does not have attachment device.
    - b. Use eye pins or threaded studs with screw-on eyes in existing or

already placed concrete structures to support hanger and bracing wire.

C. Direct Hung Suspension System:

1. As illustrated in ASTM C635.
2. Support main runners by hanger wires attached directly to the structure overhead.
3. Maximum spacing of hangers, 1200 mm (4 feet) on centers unless interference occurs by mechanical systems. Use indirect hung suspension system where not possible to maintain hanger spacing.

D. Indirect Hung Suspension System:

1. As illustrated in ASTM C635.
2. Space carrying channels for indirect hung suspension system not more than 1200 mm (4 feet) on center. Space hangers for carrying channels not more than 2400 mm (8 feet) on center or for carrying channels less than 1200 mm (4 feet) on center so as to insure that specified requirements are not exceeded.
3. Support main runners by specially designed clips attached to carrying channels.

E. Seismic Ceiling Bracing System:

1. Construct system in accordance with ASTM E580.
2. Connect bracing wires to structure above as specified for anchorage to structure and to main runner or carrying channels

### **3.3 ACOUSTICAL UNIT INSTALLATION**

- A. Cut acoustic units for perimeter borders and penetrations to fit tight against penetration for joint not concealed by molding.
- B. Install lay-in acoustic panels in exposed grid with not less than 6 mm (1/4 inch) bearing at edges on supports.
1. Install tile to lay level and in full contact with exposed grid.
  2. Replace cracked, broken, stained, dirty, or tile not cut for minimum bearing.
- C. Markers:
1. Install markers of color code specified to identify the various concealed piping, mechanical, and plumbing systems.
  2. Attach colored markers to exposed grid on opposite sides of the units providing access.
  3. Attach marker on exposed ceiling surface of upward access acoustical unit.

### **3.4 CLEAN-UP AND COMPLETION**

- A. Replace damaged, discolored, dirty, cracked and broken acoustical units.

- B. Leave finished work free from defects.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 65 13**

**RESILIENT BASE AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the installation of vinyl or rubber base.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color and texture: Section 09 06 00, SCHEDULE FOR FINISHESS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
1. Description of each product.
  2. Base and stair material manufacturer's recommendations for adhesives.
  3. Application and installation instructions.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Samples:
1. Base: 150 mm (6 inches) long, each type and color.
  2. Adhesive: Literature indicating each type.

**1.4 DELIVERY**

- A. Deliver materials to the site in original sealed packages or containers, clearly marked with the manufacturer's name or brand, type and color, production run number and date of manufacture.
- B. Materials from containers which have been distorted, damaged or opened prior to installation will be rejected.

**1.5 STORAGE**

- A. Store materials in weather tight and dry storage facility.
- B. Protect material from damage by handling and construction operations before, during, and after installation.

**1.6 APPLICABLE PUBLICATIONS**

- A. The publication listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. F1344-10 Rubber Floor Tile
  - 2. F1861-08 Resilient Wall Base
- C. Federal Specifications (Fed. Spec.):
  - 1. RR-T-650E Treads, Metallic and Non-Metallic, Nonskid

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Use only products by the same manufacturer and from the same production run.

**2.2 RESILIENT BASE**

- A. ASTM F1861, 3 mm (1/8 inch) thick, 100 mm (4 inches) high, Type TP Rubber, Thermoplastics, Group 2-layered with molded top. Style B-cove.
- B. Use only one type of base throughout.

**2.3 ADHESIVES**

- A. Use products recommended by the material manufacturer for the conditions of use.
- B. Use low-VOC adhesive during installation. Water based adhesive with low VOC is preferred over solvent based adhesive.

### **PART 3 - EXECUTION**

#### **3.1 PROJECT CONDITIONS**

- A. Maintain temperature of materials above 21° C (70° F), for 48 hours before installation.
- B. Maintain temperature of rooms where work occurs, between 21° C and 27° C (70° F and 80° F) for at least 48 hours, before, during, and after installation.
- C. Do not install materials until building is permanently enclosed and wet construction is complete, dry, and cured.

#### **3.2 INSTALLATION REQUIREMENTS**

- A. The respective manufacturer's instructions for application and installation will be considered for use when approved by the Resident Engineer.
- B. Submit proposed installation deviation from this specification to the Resident Engineer indicating the differences in the method of installation.
- C. The Resident Engineer reserves the right to have test portions of material installation removed to check for non-uniform adhesion and spotty adhesive coverage.

#### **3.3 PREPARATION**

- A. Examine surfaces on which material is to be installed.
- B. Fill cracks, pits, and dents.
- C. Level to 3 mm (1/8 inch) maximum variations.
- D. Do not use adhesive for filling.
- E. Grind, sand, or cut away protrusions; grind high spots.
- F. Clean substrate area of oil, grease, dust, paint, and deleterious substances.
- G. Substrate area dry and cured. Perform manufacturer's recommended bond and moisture test.

#### **3.4 BASE INSTALLATION**

- A. Location:
  - 1. Unless otherwise specified or shown, where base is scheduled, install base over toe space of base of casework, lockers, laboratory, pharmacy furniture island cabinets and where other equipment occurs.
  - 2. Extend base scheduled for room into adjacent closet, alcoves, and around columns.

B. Application:

1. Apply adhesive uniformly with no bare spots.
2. Set base with joints aligned and butted to touch for entire height.
3. Before starting installation, layout base material to provide the minimum number of joints with no strip less than 600 mm (24 inches) length.
  - a. Short pieces to save material will not be permitted.
  - b. Locate joints as remote from corners as the material lengths or the wall configuration will permit.

C. Form corners and end stops as follows:

1. Score back of outside corner.
2. Score face of inside corner and notch cove.

D. Roll base for complete adhesion.

**3.5 CLEANING AND PROTECTION**

- A. Clean all exposed surfaces of base and adjoining areas of adhesive spatter before it sets.
- B. Where protective materials are removed and immediately prior to acceptance, replace damaged materials and re-clean resilient materials. Damaged materials are defined as having cuts, gouges, scrapes or tears and not fully adhered.

**3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 65 16.13**

**LINOLEUM FLOORING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section Includes:
  - 1. Linoleum sheet flooring.

**1.2 Related Sections:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 09 65 13 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with linoleum floor covering.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: For each type of product indicated.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
  - 3. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC contents.
  - 4. Product Data for Credit IEQ 4.3: For adhesives, documentation including printed statement of VOC contents.
  - 5. Product Data for Credit IEQ 4.3: For linoleum, documentation from an independent testing agency indicating compliance with the FloorScore Standard.

- D. Shop Drawings: For each type of floor covering. Include floor covering layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  - 1. Show details of special patterns.
- E. Samples for Verification: In manufacturer's standard size, but not less than 6-by-9-inch (152-by-230-mm) sections of each color and pattern of floor covering required.
- F. Maintenance Data: For each type of floor covering to include in maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor covering installation.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.
- B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockups for floor coverings including resilient base and accessories.
    - a. Size: Minimum 100 sq. ft. (9.2 sq. m) for each type, color, and pattern in locations directed by Resident Engineer.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store floor coverings and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F (18 deg C) or more than 90 deg F (32 deg C).
  - 1. Sheet Flooring: Store rolls upright.

#### **1.6 PROJECT CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive floor coverings during the following time periods:
  - 1. 72 hours before installation.
  - 2. During installation.
  - 3. 72 hours after installation.

- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Close spaces to traffic during floor covering installation.
- D. Close spaces to traffic for 72 hours after floor covering installation.
- E. Install floor coverings after other finishing operations, including painting, have been completed.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. FloorScore Compliance: Linoleum shall comply with requirements of FloorScore Standard.

### **2.2 LINOLEUM FLOOR COVERING**

- A. Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing.
  - 1. Roll Size: In manufacturer's standard length by not less than 78 inches (1980 mm) wide.
  - 2. Protective Coating: Manufacturer's high performance coating designed to resist dirt buildup, improve scuff resistance, protect from chemical spills, resist discoloration from pH cleaners and other chemicals.
- B. Seaming Method: Standard.
- C. Thickness: 0.10 inch (2.5 mm).
- D. Colors and Patterns: Refer to Section 09 06 00, SCHEDULE FOR FINISHES.

### **2.3 INSTALLATION MATERIALS**

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Edge Strips: As specified in Sections 09 65 19, RESILIENT TILE FLOORING, and Section 09 68 00, CARPETING.
- D. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor coverings.
  - 1. Verify that floor slope and changes in elevation meets the requirements of Architectural Barriers Act Accessibility Standards (ABAAS) and VA Barrier Free Design Guide (PG-18-13).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of floor coverings.
- B. Concrete Substrates: Prepare according to ASTM F 710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with floor covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
  - 4. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
    - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    - b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.
    - c. Refer to Section 07 26 13.13, CONCRETE SLAB APPLIED VAPOR RETARDER, for vapor emission testing and application of vapor retarders.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

- D. Do not install floor coverings until they are same temperature as space where they are to be installed.
  - 1. Move floor coverings and installation materials into spaces where they will be installed at least 72 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

### **3.3 INSTALLATION, GENERAL**

- A. Comply with manufacturer's written instructions for installing floor coverings.
- B. Scribe and cut floor coverings to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- C. Extend floor coverings into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, or openings that are in place or marked for future cutting by repeating on floor coverings as marked on subfloor. Use chalk or other nonpermanent marking device.
- E. Adhere floor coverings to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

### **3.4 LINOLEUM SHEET FLOORING INSTALLATION**

- A. Unroll sheet floorings and allow them to stabilize before cutting and fitting.
- B. Lay out sheet floorings as follows:
  - 1. Maintain uniformity of floor covering direction.
  - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches (152 mm) away from parallel joints in floor covering substrates.
  - 3. Match edges of floor coverings for color shading at seams.
  - 4. Avoid cross seams.
  - 5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

### **3.5 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protection of floor coverings.

- B. Perform the following operations immediately after completing floor covering installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor coverings from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from floor coverings before applying liquid floor polish.
  - 1. Apply two coat(s).
- E. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover floor coverings until Substantial Completion.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 84 33**

**SOUND-ABSORBING WALL AND CEILING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section Includes:
1. Patterned, sound-absorptive wall and ceiling panels.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: Manufacturer's technical data for each type of panel and baffle including fire-resistive characteristics, finishes, details of installation, and the following:
1. Manufacturer's installation instructions.
  2. Certified test reports indicating compliance with Performance Requirements specified herein.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Samples: 2 full size sets of Samples of the following specified units for color selection or verification.
1. Panels.
- E. Closeout Submittals: Comply with Section 01 77 00 - Closeout Procedures.
1. Operating and Maintenance Manual, including cleaning and maintenance instructions.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Firm with not less than 5 years experience in manufacturing of products similar in complexity to those required for this Project.
- B. Installer's Qualifications: Firm with not less than 5 years experience in installation of products similar in complexity to those required for this Project, including specific requirements indicated.
  - 1. Successfully completed not less than 5 comparable scale projects.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver and store materials in manufacturer's original unopened containers with brands, names, and production lot numbers clearly marked on these containers.
- B. Storage and Protection: Comply with manufacturer's recommendations.
  - 1. Store products in a cool, dry place out of direct sunlight.
  - 2. Protect from elements and from damage.

#### **1.6 PROJECT CONDITIONS**

- A. Environmental Requirements within building:
  - 1. Panels do not require special environmental conditions.
  - 2. Systems may be installed at any stage of construction.
  - 3. Systems may be installed in cool storage rooms and rooms with high humidity

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURED UNITS**

#### **2.2 SOUND-ABSORBING WALL PANELS**

- A. Acoustical Wall and Ceiling Panels: Lightweight, open-cell foam panel made from porous melamine, meeting the following requirements:
  - 1. Density: 0.5 to 0.7 pounds per cubic foot (0.23 to 0.32 kg per m<sup>3</sup>).
  - 2. Tensile Strength: 8 psi (0.06 MPa).
  - 3. Flammability: Class A per ASTM E84.
    - a. Flame Spread: 5
    - b. Smoke Density: 50
  - 4. Panel Size: 24 inch by 48 inch (610 mm by 1219 mm).
  - 5. Panel Thickness: 2 inches (51 mm).
  - 6. Color/Finish: Grey.



7. Sound Absorption Coefficients: Type B and A mountings, ASTM C423-90a.

Frequencies (Hz):	125	250	500	1,000	2,000	4,000	NRC	
	Mounting							
2 inch (51 mm):	0.05	0.31	0.81	1.01	0.99	0.95	0.80	A

### 2.3 ACCESSORIES

- A. Adhesive: Type recommended by manufacturer, non-toxic, water-based adhesive, for use with foam products.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and or timely completion.
1. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prior to installing acoustical panels, make certain that surfaces to which adhesive will be applied are clean and free of dust, dirt, and other residues that would inhibit a proper bond.

### 3.3 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation of the following units.
1. Panels.
- B. Acoustical Panels:
1. Cut adhesive tube end to produce a 1/4 inch (6.4 mm) bead.
  2. Apply adhesive to panels per manufacturer's recommended pattern and press panel firmly into place per manufacturer's installation requirements.
  3. Install panels true to lines and plane indicated.

### 3.4 CLEANING

- A. Clean adjacent surfaces and remove unused product and debris from site.
- B. After installation is completed, clean soiled surfaces of materials.
- C. Remove and reinstall improperly installed material.
- D. Remove damaged or discolored material, or material that cannot be properly cleaned, and install new material.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 09 91 00**

**PAINTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Section specifies field painting.
- B. Section specifies prime coats which may be applied in shop under other sections.
- C. Painting includes markers and identity markings.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Shop prime painting of steel and ferrous metals: Division 05 - METALS, Division 08 - OPENINGS, Division 10 - SPECIALTIES, Division 21 - FIRE SUPPRESSION, Division 22 - PLUMBING, Division 23 - HEATING, VENTILATION AND AIR-CONDITIONING, Division 26 - ELECTRICAL, Division 27 - COMMUNICATIONS, and Division 28 - ELECTRONIC SAFETY AND SECURITY sections.
- D. Type of Finish, Color, and Gloss Level of Finish Coat: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Before work is started, or sample panels are prepared, submit manufacturer's literature, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of Contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one list may be used for the entire Contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.

- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Sample Panels:
1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.
  2. Panels to show color: Composition board, 100 by 250 by 3 mm (4 inch by 10 inch by 1/8 inch).
  3. Attach labels to panel stating the following:
    - a. Federal Specification Number or manufacturers name and product number of paints used.
    - b. Specification code number specified in Section 09 06 00, SCHEDULE FOR FINISHES.
    - c. Product type and color.
    - d. Name of project.
  4. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.
- E. Sample of identity markers.
- F. Manufacturers' Certificates indicating compliance with specified requirements:
1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
  2. High temperature aluminum paint.
  3. Epoxy coating.

#### **1.4 DELIVERY AND STORAGE**

- A. Deliver materials to site in manufacturer's sealed container marked to show following:
1. Name of manufacturer.
  2. Product type.
  3. Batch number.
  4. Instructions for use.
  5. Safety precautions.

- B. In addition to manufacturer's label, provide a label legibly printed as following:
  - 1. Federal Specification Number, where applicable, and name of material.
  - 2. Surface upon which material is to be applied.
  - 3. If paint or other coating, state coat types; prime, body or finish.
- C. Maintain space for storage, and handling of painting materials and equipment in a neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- D. Store materials at site at least 24 hours before using, at a temperature between 18 and 30 degrees C (65 and 85 degrees F).

#### **1.5 MOCK-UP PANEL**

- A. Before starting application of water paint mixtures,, apply paint as specified to an area, not to exceed 9 m2 (100 ft<sup>2</sup>), selected by Resident Engineer.
- B. Finish and texture approved by Resident Engineer will be used as a standard of quality for remainder of work.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. American Conference of Governmental Industrial Hygienists (ACGIH):
  - 1. ACGIH TLV-BKLT-2008 Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)
  - 2. ACGIH TLV-DOC-2008 Documentation of Threshold Limit Values and Biological Exposure Indices, (Seventh Edition)
- C. American National Standards Institute (ANSI):
  - 1. A13.1-96 Scheme for the Identification of Piping Systems
- D. American Society for Testing and Materials (ASTM):
  - 1. D260-86 Boiled Linseed Oil
- E. Bay Area Air Quality Management District (BAAQMD):
  - 1. Reg. 8, Rule 3 Architectural Coatings.
- F. Commercial Item Description (CID):
  - 1. A-A-1555 Water Paint, Powder (Cementitious, White and Colors) (WPC) (cancelled)
  - 2. A-A-3120 Paint, For Swimming Pools (RF) (cancelled)

G. Master Painters Institute (MPI):

1. 18-07 Organic Zinc Rich Primer
2. 22-07 Aluminum Paint, High Heat (up to 590° - 1100F) (HR)
3. 36-07 Knot Sealer
4. 39-07 Primer, Latex for Interior Wood
5. 48-07 Interior Alkyd, Gloss, MPI Gloss Level 6 (AK)
6. 50-07 Interior Latex Primer Sealer
7. 52-07 Interior Latex, MPI Gloss Level 3 (LE)
8. 53-07 Interior Latex, Flat, MPI Gloss Level 1 (LE)
9. 54-07 Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE)
10. 101-07 Epoxy Anti-Corrosive Metal Primer
11. 107-07 Rust Inhibitive Primer, Water Based
12. 134-07 Primer, Galvanized, Water Based
13. 139-07 Interior High Performance Latex, MPI Gloss Level 3 (LL)
14. 141-07 Interior High Performance Latex (SG) MPI Gloss Level 5
15. 161-07 Light Industrial Coating, Exterior Water-Based (Gloss Level 3)
16. 163-07 Light Industrial Coating, Exterior Water-Based (Gloss Level 5)
17. 301-07 Primer, Epoxy-Modified Latex Anti-Corrosive, for Metal

H. Steel Structures Painting Council (SSPC):

1. SSPC SP 1-04 (R2004) Solvent Cleaning
2. SSPC SP 2-04 (R2004) Hand Tool Cleaning
3. SSPC SP 3-04 (R2004) Power Tool Cleaning

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. Plastic Tape:

1. Pigmented vinyl plastic film in colors as specified in Section 09 06 00, SCHEDULE FOR FINISHES or specified.
2. Pressure sensitive adhesive back.
3. Widths as shown.

B. Identity markers options:

1. Pressure sensitive vinyl markers.
2. Snap-on coil plastic markers.

- C. Organic Zinc rich Coating (HR): MPI 18.
- D. High Heat Resistant Coating (HR): MPI 22.
- E. Knot Sealer: MPI 36.
- F. Interior Primer Latex: MPI 39.
- G. Interior Latex Primer Sealer: MPI 50.
- H. Interior Latex, MPI Gloss Level 3 (LE): MPI 52.
- I. Interior Latex, Flat, MPI Gloss Level 1 (LE): MPI 53.
- J. Interior Latex, Semi-Gloss, MPI Gloss Level 5 (LE): MPI 54.
- K. Marine Alkyd Metal primer: MPI 79.
- L. Epoxy Anti-Corrosive Metal Primer: MPI 101.
- M. Rust Inhibitive Primer, Water Based: MPI 107.
- N. Epoxy-Modified Latex Anti-Corrosive Primer: MPI 301
- O. Waterborne Galvanized Primer: MPI 134.
- P. Interior High Performance Latex, MPI Gloss Level 3 (LL): MPI 139.
- Q. Interior High Performance Latex (SG), MPI Gloss Level 5: MPI 141.
- R. Light Industrial Coating, Exterior Water-Based (Gloss Level 3): MPI 161
- S. Light Industrial Coating, Exterior Water-Based, Semi-Gloss (Gloss Level 5): MPI 163
- T. Concrete Penetrating Sealer: Chemically reactive, waterborne solution of inorganic silicate or silicate materials; odorless, colorless penetrates, densifies, and hardens concrete surfaces. VOC Content: Less than 100 g/L.

## **2.2 PAINT PROPERTIES**

- A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.
- B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

## **2.3 REGULATORY REQUIREMENTS/QUALITY ASSURANCE**

- A. Paint materials shall conform to the restrictions of the Bay Area Air Quality Management District (BAAQMD).
  - 1. Volatile Organic Compounds (VOC): VOC content of paint materials shall not exceed 10g/l for interior latex paints/primers and 50g/l for exterior latex paints and primers.
  - 2. Lead-Base Paint:
    - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
    - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
    - c. For lead-paint removal, see Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
  - 3. Asbestos: Materials shall not contain asbestos.
  - 4. Chromate, Cadmium, Mercury, and Silica: Materials shall not contain zinc- chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
  - 5. Human Carcinogens: Materials shall not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
  - 6. Use high performance acrylic paints in place of alkyd paints, where possible.
  - 7. VOC content for solvent-based paints shall not exceed 250g/l and shall not be formulated with more than one percent aromatic hydro carbons by weight.

## **PART 3 - EXECUTION**

### **3.1 JOB CONDITIONS**

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
  - 1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
  - 2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each days work.
- B. Atmospheric and Surface Conditions:
  - 1. Do not apply coating when air or substrate conditions are:
    - a. Less than 3 degrees C (5 degrees F) above dew point.



- b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the Contracting Officer and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.
- 2. Maintain interior temperatures until paint dries hard.
- 3. Do no exterior painting when it is windy and dusty.
- 4. Do not paint in direct sunlight or on surfaces that the sun will soon warm.
- 5. Apply only on clean, dry and frost free surfaces.follows:

### **3.2 SURFACE PREPARATION**

- A. Method of surface preparation is optional, provided results of finish painting produce solid even color and texture specified with no overlays.
- B. General:
  - 1. Remove prefinished items not to be painted such as lighting fixtures, escutcheon plates, hardware, trim, and similar items for reinstallation after paint is dried.
  - 2. Remove items for reinstallation and complete painting of such items and adjacent areas when item or adjacent surface is not accessible or finish is different.
  - 3. See other sections of specifications for specified surface conditions and prime coat.
  - 4. Clean surfaces for painting with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry.
- C. Wood:
  - 1. Sand to a smooth even surface and then dust off.
  - 2. Sand surfaces showing raised grain smooth between each coat.
  - 3. Wipe surface with a tack rag prior to applying finish.
  - 4. Surface painted with an opaque finish:
    - a. Coat knots, sap and pitch streaks with MPI 36 (Knot Sealer) before applying paint.
  - 5. After application of prime or first coat of stain, fill cracks, nail and screw holes, depressions and similar defects with wood filler paste. Sand the surface to make smooth and finish flush with adjacent surface.
- D. Ferrous Metals:
  - 1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).

2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning). Exception: where high temperature aluminum paint is used, prepare surface in accordance with paint manufacturer's instructions.
  3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two- Component Type, For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.
    - a. This includes flat head countersunk screws used for permanent anchors.
    - b. Do not fill screws of item intended for removal such as glazing beads.
  4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
  5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.
- E. Zinc-Coated (Galvanized) Metal, Surfaces Specified Painted:
1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
  2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non- Cementitious Galvanized Primer) depending on finish coat compatibility.
- F. Concrete:
1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
  2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.
  3. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.
- G. Gypsum Board:
1. Remove efflorescence, loose and chalking plaster or finishing materials.
  2. Remove dust, dirt, and other deterrents to paint adhesion.
  3. Fill holes, cracks, and other depressions with CID-A-A-1272A Gypsum (Spackling Compound) finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

### **3.3 PAINT PREPARATION**

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two component and two part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.
- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

### **3.4 APPLICATION**

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
- B. Unless otherwise specified, apply paint in three coats; prime, body, and finish. When two coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
- D. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by Resident Engineer.
- E. Finish surfaces to show solid even color, free from runs, lumps, brushmarks, laps, holidays, or other defects.
- F. Apply by brush, roller or spray, except as otherwise specified.
- G. Do not spray paint in existing occupied spaces unless approved by Resident Engineer, except in spaces sealed from existing occupied spaces.
  - 1. Apply painting materials specifically required by manufacturer to be applied by spraying.
  - 2. In areas, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in WORK NOT PAINTED, motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- H. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

### **3.5 PRIME PAINTING**

- A. After surface preparation prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required except for exterior exposed steel apply an additional prime coat.
- D. Prime rebates for stop and face glazing of wood, and for face glazing of steel.

### **3.6 EXTERIOR PAINTING SCHEDULE**

- A. Apply following finish coats where specified in Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Concrete substrates, non-traffic surfaces:
  - 1. Concrete Walls: Refer to Section 07 19 00, WATER REPELLENTS.
- C. Steel and ferrous metal substrates:
  - 1. Water-Based Light Industrial Coating System:
    - a. Prime Coat (Shop Primer): Epoxy-modified Latex Primer (MPI #301) or Epoxy Anti-corrosive Metal Primer (MPI #101).
    - b. Prime Coat: Epoxy-modified Latex Primer (MPI #301).
    - c. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - d. Topcoat: Refer to Section 09 06 00 - SCHEDULE FOR FINISHES and Drawings for Gloss Level. Apply one of the following:
      - 1) Light industrial coating, exterior, water based, Gloss Level 3 (MPI #161).
      - 2) Light industrial coating, exterior, water based, semi-gloss, Gloss Level 5 (MPI #163).
- D. Galvanized-metal substrates:
  - 1. Water-Based Light Industrial Coating System:
    - a. Prime Coat (Shop Primer): Epoxy-modified Latex Primer (MPI #301) or Epoxy Anti-corrosive Metal Primer (MPI #101).
    - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - c. Topcoat: Refer to Section 09 06 00 - SCHEDULE FOR FINISHES and Drawings for Gloss Level. Apply one of the following:
      - 1) Light industrial coating, exterior, water based, Gloss Level 3 (MPI #161).
      - 2) Light industrial coating, exterior, water based, semi-gloss, Gloss Level 5 (MPI #163).

- E. Stainless-steel sheet and aluminum metal flashing:
  - 1. Water-Based Light Industrial Coating System:
    - a. Prime Coat: Waterborne Galvanized Primer (MPI #134).
    - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - c. Topcoat: Light industrial coating, exterior, water based, semi-gloss, Gloss Level 5 (MPI #163).
- F. Machinery without factory finish except for primer:
  - 1. Water-Based Light Industrial Coating System:
    - a. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
    - b. Topcoat: Direct to metal (DTM) Light industrial coating, exterior, water based, semi-gloss, Gloss Level 5 (MPI #163).

### **3.7 INTERIOR PAINTING SCHEDULE**

- A. Apply following finish coats over prime coats in spaces or on surfaces specified in Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Concrete substrates, non-traffic surfaces:
  - 1. Concrete Walls: Refer to Section 07 19 00, WATER REPELLENTS.
- C. Concrete Substrates, Traffic Surfaces:
  - 1. Clear Penetrating Sealer System:
    - a. First Coat: Penetrating Sealer, water based, for concrete floors.
    - b. Topcoat: Penetrating Sealer, water based, for concrete floors.
- D. Steel Substrates:
  - 1. High-Performance Architectural Latex System:
    - a. Prime Coat (Shop Primer): Primer, Alkyd, Anti-Corrosive for Metal (MPI #79).
    - b. Touch-up Primer: Rust Inhibitive Primer, Water Based (MPI #107).
    - c. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
    - d. Topcoat: Latex, interior, high performance architectural, Gloss Level 3 (MPI #139).
- E. Wood Substrates:
  - 1. High-Performance Architectural Latex System:
    - a. Prime Coat: Primer, latex, for interior wood (MPI #39).
    - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
    - c. Topcoat: Latex, interior, high performance architectural, Gloss Level 3 (MPI #139).

F. Gypsum Board Substrates:

1. High-Performance Architectural Latex System (apply at substrates exposed to high humidity or moisture):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
  - c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5) (MPI #141).
2. Latex System:
  - a. Prime Coat: Primer sealer, latex, interior (MPI #50).
  - b. Prime Coat: Latex, interior, matching topcoat.
  - c. Intermediate Coat: Latex, interior, matching topcoat.
  - d. Topcoat: Refer to Section 09 06 00 - SCHEDULE FOR FINISHES and Drawings for Gloss Level. Apply one of the following:
    - 1) Latex, interior, flat, Gloss Level (MPI #53).
    - 2) Topcoat: Latex, interior, Gloss Level 3 (MPI #52).
    - 3) Topcoat: Latex, interior, semi-gloss, Gloss Level 5 (MPI #54).

**3.8 PAINT COLOR**

- A. Color and gloss of finish coats is specified in Section 09 06 00, SCHEDULE FOR FINISHES.
- B. For additional requirements regarding color see Articles, REFINISHING EXISTING PAINTED SURFACE and MECHANICAL AND ELECTRICAL FIELD PAINTING SCHEDULE.
- C. Coat Colors:
  1. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.
- D. Painting, Caulking, Closures, and Fillers Adjacent to Casework:
  1. Paint to match color of casework where casework has a paint finish.
  2. Paint to match color of wall where casework is stainless steel, plastic laminate, or varnished wood.

**3.9 MECHANICAL AND ELECTRICAL WORK FIELD PAINTING SCHEDULE**

- A. Field painting of mechanical and electrical consists of cleaning, touching-up abraded shop prime coats, and applying prime, body and finish coats to materials and equipment if not factory finished in space scheduled to be finished.
- B. In spaces not scheduled to be finish painted in Section 09 06 00, SCHEDULE FOR FINISHES paint as specified under paragraph H, colors.
- C. Paint various systems specified in Division 02 - EXISTING CONDITIONS, Division 21 - FIRE SUPPRESSION, Division 22 - PLUMBING, Division 23 -

HEATING, VENTILATION AND AIR-CONDITIONING, Division 26 - ELECTRICAL, Division 27 - COMMUNICATIONS, and Division 28 - ELECTRONIC SAFETY AND SECURITY.

- D. Paint after tests have been completed.
- E. Omit prime coat from factory prime-coated items.
- F. Finish painting of mechanical and electrical equipment is not required when located in interstitial spaces, above suspended ceilings, in concealed areas such as pipe and electric closets, pipe basements, pipe tunnels, trenches, attics, roof spaces, shafts and furred spaces except on electrical conduit containing feeders 600 volts or more.
- G. Omit field painting of items specified in paragraph, Building and Structural WORK NOT PAINTED.
- H. Color:
  - 1. Paint items having no color specified in Section 09 06 00, SCHEDULE FOR FINISHES to match surrounding surfaces.
  - 2. Paint colors as specified in Section 09 06 00, SCHEDULE FOR FINISHES except for following:
    - a. White: Exterior unfinished surfaces of enameled plumbing fixtures. Insulation coverings on breeching and uptake inside boiler house, drums and drum-heads, oil heaters, condensate tanks and condensate piping.
    - b. Gray: Heating, ventilating, air conditioning and refrigeration equipment (except as required to match surrounding surfaces), and water and sewage treatment equipment and sewage ejection equipment.
    - c. Aluminum Color: Ferrous metal on outside of boilers and in connection with boiler settings including supporting doors and door frames and fuel oil burning equipment, and steam generation system (bare piping, fittings, hangers, supports, valves, traps and miscellaneous iron work in contact with pipe).
    - d. Federal Safety Red: Exposed fire protection piping hydrants, post indicators, electrical conducts containing fire alarm control wiring, and fire alarm equipment.
    - e. Federal Safety Orange: Entire lengths of electrical conduits containing feeders 600 volts or more.
    - f. Color to match brickwork sheet metal covering on breeching outside of exterior wall of boiler house.
- I. Apply paint systems on properly prepared and primed surface as follows:
  - 1. Exterior Locations:
    - a. Apply two coats of direct to metal (DTM) Light Industrial Coating, Exterior Water-Based, Semi-Gloss (Gloss Level 5) MPI 163 to the following ferrous metal items: Vent and exhaust pipes with temperatures under 94 degrees C (200 degrees F), roof drains, fire hydrants, post indicators, yard hydrants, exposed piping and similar items.

- b. Apply two coats of direct to metal (DTM) Light Industrial Coating, Exterior Water-Based, Semi-Gloss (Gloss Level 5) MPI 163 to the following metal items: Galvanized and zinc-copper alloy metal.
  - c. Apply one coat of MPI 22 (High Heat Resistant Coating (HR)), 650 degrees C (1200 degrees F) to incinerator stacks, boiler stacks, and engine generator exhaust.
2. Interior Locations:
- a. Apply two coats of direct to metal (DTM) Light Industrial Coating, Exterior Water-Based, Semi Gloss (Glss Level 5) MPI 163 to following items:
    - 1) Metal under 94 degrees C (200 degrees F) of items such as bare piping, fittings, hangers and supports.
    - 2) Equipment and systems such as hinged covers and frames for control cabinets and boxes, cast-iron radiators, electric conduits and panel boards.
    - 3) Heating, ventilating, air conditioning, plumbing equipment, and machinery having shop prime coat and not factory finished.
  - b. Apply two coats of MPI 22 (High Heat Resistant Coating (HR)) to ferrous metal surface over 94 degrees K (200 degrees F) of following items:
    - 1) Exhaust piping and muffler.

### **3.10 BUILDING AND STRUCTURAL WORK FIELD PAINTING**

- A. Painting and finishing of interior and exterior work except as specified under paragraph 3.11 B.
- 1. Painting and finishing of new[ **and existing**] work including colors and gloss of finish selected is specified in Finish Schedule, Section 09 06 00, SCHEDULE FOR FINISHES.
  - 2. Painting of disturbed, damaged and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
  - 3. Painting of ferrous metal and galvanized metal.
  - 4. Painting of wood with fire retardant paint exposed in attics, when used as mechanical equipment space except shingles.
  - 5. Identity painting and safety painting.
- B. Building and Structural Work not Painted:
- 1. Prefinished items:
    - a. Casework, metal panels, and similar items specified factory finished under other sections.
  - 2. Finished surfaces:
    - a. Hardware except ferrous metal.
    - b. Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
    - c. Signs, fixtures, and other similar items integrally finished.



3. Concealed surfaces:
  - a. Inside walls or other spaces behind access doors or panels.
  - b. Surfaces concealed behind permanently installed casework and equipment.
4. Moving and operating parts:
  - a. Chains, gears, mechanical and electrical operators, linkages, and sprinkler heads, and sensing devices.
  - b. Tracks for overhead or coiling doors, shutters, and grilles.
5. Labels:
  - a. Code required label, such as Underwriters Laboratories Inc., Inchcape Testing Services, Inc., or Factory Mutual Research Corporation.
  - b. Identification plates, instruction plates, performance rating, and nomenclature.
6. Metal safety treads and nosings.
7. Gaskets.
8. Structural steel encased in concrete, or other enclosure.

### **3.11 IDENTITY PAINTING SCHEDULE**

- A. Identify designated service in accordance with ANSI A13.1, unless specified otherwise, on exposed piping, piping above removable ceilings, piping in accessible pipe spaces, interstitial spaces, and piping behind access panels.
  1. Legend may be identified using 2.1 G options or by stencil applications.
  2. Apply legends adjacent to changes in direction, on branches, where pipes pass through walls or floors, adjacent to operating accessories such as valves, regulators, strainers and cleanouts a minimum of 12000 mm (40 feet) apart on straight runs of piping. Identification next to plumbing fixtures is not required.
  3. Locate Legends clearly visible from operating position.
  4. Use arrow to indicate direction of flow.
  5. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard. Insert working pressure shown on drawings where asterisk appears for High, Medium, and Low Pressure designations as follows:
    - a. High Pressure - 414 kPa (60 psig) and above.
    - b. Medium Pressure - 104 to 413 kPa (15 to 59 psig).
    - c. Low Pressure - 103 kPa (14 psig) and below.
    - d. Add Fuel oil grade numbers.

## 6. Legend name in full or in abbreviated form as follows:

PIPING	COLOR OF EXPOSED PIPING	COLOR OF BACK- GROUND	COLOR OF LETTERS	LEGEND ABBREVIATIONS
Blow-off		Yellow	Black	Blow-off
Boiler Feedwater		Yellow	Black	Blr Feed
A/C Condenser Water Supply		Green	White	A/C Cond Wtr Sup
A/C Condenser Water Return		Green	White	A/C Cond Wtr Ret
Chilled Water Supply		Green	White	Ch. Wtr Sup
Chilled Water Return		Green	White	Ch. Wtr Ret
Drain Line		Green	White	Drain
High Pressure Steam		Yellow	Black	H.P. 100 psig*
High Pressure Condensate Return		Yellow	Black	H.P. Ret 100 psig*
Medium Pressure Steam		Yellow	Black	M. P. Stm 50 psig*
Medium Pressure Condensate Return		Yellow	Black	M.P. Ret 50 psig*
Low Pressure Steam		Yellow	Black	L.P. Stm 15 psig*
Low Pressure Condensate Return		Yellow	Black	L.P. Ret 15 psig*
Hot Water Heating Supply		Yellow	Black	H. W. Htg Sup
Hot Water Heating Return		Yellow	Black	H. W. Htg Ret
Gravity Condensate Return		Yellow	Black	Gravity Cond Ret
Pumped Condensate Return		Yellow	Black	Pumped Cond Ret
Pumped Condensate		Black		Pump Cond
Pump Recirculating		Yellow	Black	Pump-Recirc.
Vent Line		Yellow	Black	Vent
Cold Water (Domestic)	White	Green	White	C.W. Dom
Hot Water (Domestic)				
Supply	White	Yellow	Black	H.W. Dom
Return	White	Yellow	Black	H.W. Dom Ret
Sanitary Waste		Green	White	San Waste
Sanitary Vent		Green	White	San Vent
Storm Drainage		Green	White	St Drain
Pump Drainage		Green	White	Pump Disch
Atmospheric Vent		Green	White	ATV
Fuel Gas		Yellow	Black	Gas
Fire Protection Water				
Sprinkler		Red	White	Auto Spr
Standpipe		Red	White	Stand
Sprinkler		Red	White	Drain

## 7. See Sections for methods of identification, legends, and abbreviations of the following:

## B. Fire and Smoke Partitions:

1. Identify partitions above ceilings on both sides of partitions except within shafts in letters not less than 64 mm (2 1/2 inches) high.
2. Stenciled message: "SMOKE BARRIER" or, "FIRE BARRIER" as applicable.
3. Locate not more than 6100 mm (20 feet) on center on corridor sides of partitions, and with a least one message per room on room side of partition.
4. Use semigloss paint of color that contrasts with color of substrate.

**3.12 PROTECTION CLEAN UP, AND TOUCH-UP**

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

**3.13 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 09 96 54**

**POLYVINYLIDENE DIFLOUORIDE (PVDF) COATING SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Summary: Section includes shop-applied polyvinylidene diflouoride (PVDF) extrusion coatings also known as high-performance organic finish, baked-on fluorocarbon finish, or special fluoropolymer finish as specified in other sections of this Specifications to include the coatings for work of the following:
1. Section 085113 - Aluminum Windows
  2. Section 089000 - Louvers and Vents

**PART 2 - PRODUCTS**

**2.1 POLYVINYLIDENE DIFLOUORIDE (PVDF) RESIN**

- A. PVDF Resin: Highly non-reactive and pure thermoplastic fluoropolymer; fine powder grade used as principal ingredient for high-performance coating system.

**2.2 FLUOROPOLYMER PANEL AND EXTRUSION COATINGS**

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

**2.3 MISCELLANEOUS MATERIALS**

- A. Touch-up and Repair of PVDF Coatings: Two-component, fluoropolymer coating using 100 percent fluoroethylene alkyl vinyl ether (FEVE) resins and aliphatic isocyanate.

**2.4 FLUOROPOLYMER COATINGS SHOP APPLICATION**

- A. Pretreatment: Chrome phosphate based pretreatment.
- B. Methods: A system consisting of the primer and finish, each spray-applied by an approved applicator at the factory, force-cured in accordance with the coating manufacturers current printed instructions.
- C. Fluorocarbon top finish color coating shall have a minimum baking cycle of 450 deg F (232 deg C) for 20 minutes and shall have a minimum dry film thickness of 1.0 mil (0.025 mm).

**PART 3 - EXECUTION (Not Used)**

- - - E N D - - -

**SECTION 10 14 00**

**SIGNAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies interior signage for room numbers, directional signs, code required signs.
- B. This section also specifies exterior medical center identification signs, building identification signs.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Electrical: Related Electrical Specification Sections.
- D. Lighted EXIT signs for egress purposes are specified under Division 26, ELECTRICAL.
- E. Section 10 13 00, DIRECTORIES and Section **10 14 00**, SIGNAGE.
- F. Color Finish: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 MANUFACTURER'S QUALIFICATIONS**

- A. Sign manufacturer shall provide evidence that they regularly and presently manufactures signs similar to those specified in this section as one of their principal products.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Samples: Sign panels and frames, with letters and symbols, each type. Submit 2 sets. One set of samples will be retained by Resident Engineer, other returned to Contractor.
  - 1. Sign Panel, 200 mm x 250 mm (8 inches x 10 inches), with letters.
  - 2. Color samples of each color, 150 mm x 150 mm (6 inches x 6 inches). Show anticipated range of color and texture.
  - 3. Sample of typeface, arrow and symbols in a typical full size layout.

C. Manufacturer's Literature:

1. Showing the methods and procedures proposed for the concealed anchorage of the signage system to each surface type.
2. Manufacturer's printed specifications, anchorage details, installation and maintenance instructions.

D. Samples: Sign location plan, showing location, type and total number of signs required.

E. Shop Drawings: Scaled for manufacture and fabrication of sign types. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes.

F. Full size layout patterns for dimensional letters.

**1.5 DELIVERY AND STORAGE**

- A. Deliver materials to job in manufacturer's original sealed containers with brand name marked thereon. Protect materials from damage.
- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Maintain protective covering in place and in good repair until removal is necessary.
- C. Deliver signs only when the site and mounting services are ready for installation work to proceed.
- D. Store products in dry condition inside enclosed facilities.

**1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  1. B209-07 Aluminum and Aluminum-Alloy Sheet and Plate
  2. B221-06 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and tubes.
- C. Federal Specifications (Fed Spec):
  1. MIL-PRF-8184F Plastic Sheet, Acrylic, Modified.
  2. MIL-P-46144C Plastic Sheet, Polycarbonate

**1.7 MINIMUM SIGN REQUIREMENTS**

- A. Permanent Rooms and Spaces:
  1. Tactile and Braille Characters, raised minimum 0.793 mm (1/32 in). Characters shall be accompanied by Grade 2 Braille.
  2. Type Styles: Characters shall be uppercase, Helvetica Medium,



Helvetica Medium Condensed and Helvetica Regular.

3. Character Height: Minimum 16 mm (5/8 in) high, Maximum 50 mm (2 in).
4. Symbols (Pictograms): Equivalent written description shall be placed directly below symbol, outside of symbol's background field. Border dimensions of symbol background shall be minimum 150 mm (6 in) high.
5. Finish and Contrast: Characters and background shall be eggshell, matte or other non-glare finish with adequate contrast with background.
6. Mounting Location and Height: As shown. Mounted on wall adjacent to the latch side of the door and to avoid door swing and protruding objects.

B. Overhead Signs:

1. Type Styles: As shown. Characters shall have a width-to-height ratio between 3:5 and 1:1. Characters shall have a stroke width-to-height ratio of between 1:5 and 1:10.
2. Character Height: minimum 75 mm (3 in) high for overhead signs. As shown, for directional signs.
3. Finish and Contrast: Same as for signs of permanent rooms and spaces.
4. Mounting Location and Height: As shown.

**1.8 COLORS AND FINISHES:**

- A. Section 09 06 00, SCHEDULE FOR FINISHES.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Signs of type, size and design shown on the drawings and as specified.
- B. Signs complete with lettering, framing and related components for a complete installation.
- C. Provide graphics items as completed units produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.
- D. Do not scale drawings for dimensions. Contractor to verify and be responsible for all dimensions and conditions shown by these drawings. Resident Engineer to be notified of any discrepancy in drawing, in field directions or conditions, and/or of any changes required for all such construction details.
- E. The Sign Contractor, by commencing work of this section, assumes overall responsibility, as part of his warranty of work, to assure that assemblies, components and parts shown or required within the work of the section, comply with the Contract Documents. The Contractor shall further warrant: That all components, specified or required to satisfactorily complete the

installation are compatible with each other and with conditions of installations.

## **2.2 PRODUCTS**

- A. Aluminum:
  - 1. Sheet and Plate: ASTM B209.
  - 2. Extrusions and Tubing: ASTM B221.
- B. Cast Acrylic Sheet: MIL-PRF-8184F; Type II, class 1, Water white non-glare optically clear. Matt finish water white clear acrylic shall not be acceptable.
- C. Polycarbonate: Mil-P-46144C; Type I, class 1.
- D. Vinyl: 0.1 mm thick machine cut, having a pressure sensitive adhesive and integral colors.
- E. Concrete Post Footings: See Section 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE, Cast-in-place Concrete.
- F. Steel: See Section 05 12 00, STRUCTURAL STEEL FRAMING.

## **2.3 SIGN STANDARDS**

- A. Topography:
  - 1. Type Style: Trade Gothic LT Std Regular and Bold. Initial caps or all caps as indicated in Sign Message Schedule.
  - 2. Arrow: See graphic standards in drawings.
  - 3. Letter spacing: See graphic standards on drawings.
  - 4. All text, arrows, and symbols to be provided in size, colors, typefaces and letter spacing shown. Text shall be a true, clean, accurate reproduction of typeface(s) shown. Text shown in drawings are for layout purposes only; final text for signs is listed in Sign Message Schedule.
- B. Project Colors and Finishes: See Section 09 06 00, SCHEDULE FOR FINISHES.

## **2.4 SIGN TYPES**

- A. General:
  - 1. The interior sign system is comprised of sign types families that are identified by a letter and number which identify a particular group of signs. An additional number identifies a specific type of sign within that family.
    - a. IN indicates a component construction based sign.
  - 2. The exterior sign system shall be comprised of sign types families that are identified by a letter and number which identify a particular group of signs. An additional number identifies a specific type of sign within that family.

3. EI designation indicates exterior internally illuminated sign.
4. EN designation indicates exterior non-illuminated sign.

B. Sign Type Family 02:

1. All text and graphics are to be first surface silk-screened.
2. IN-01.12 & IN-01.13: Refer to Sign Type 03 specification for tactile and Braille portion of sign.
3. IN-02.4: All text and graphics are to be first surface vinyl letters.
4. IN-01.01.02: Preparation of artwork for reproduction of "fire and emergency evacuation maps" is by manufacturer.

C. Sign Type Families 03 and 300:

1. Tactile sign is to be made from a material that provides for letters, numbers and Braille to be integral with sign plaque material such as: photosensitive polyamide resin, etched metal, sandblasted phenolic or embossed material. Do not apply letters, numbers and Braille with adhesive.
2. Numbers, letters and Braille to be raised 0.793 mm (.0312 inches) from the background surface. The draft of the letters, numbers and Braille to be tapered, vertical and clean.
3. Braille dots are to conform with standard dimensions for literary Braille; (a) Dot base diameter: 1.5 mm (.059 inches) (b) Inter-dot spacing: 2.3 mm (.090 inches) (c) Horizontal separation between cells: 6.0 mm (.241 inches) (d) Vertical separation between cells: 10.0 mm (.395 inches)
4. Entire assembly is painted in specified color. After painting, apply white or other specified color to surface of the numbers and letters. Entire sign is to have a protective clear coat sealant applied.
5. Complete sign is to have an eggshell finish (11 to 19 degree on a 60 degree glossmeter).
6. Pocket depth is to be .03 mm (.0150 inches).
7. Refer to drawing sheets for exact material and dimension specifications.

D. Sign Type Family EN 06:

1. All text and graphics are to be first surface vinyl letters.

## **2.5 FABRICATION**

- A. Design components to allow for expansion and contraction for a minimum material temperature range of 56 °C (100 °F), without causing buckling, excessive opening of joints or over stressing of adhesives, welds and fasteners.
- B. Form work to required shapes and sizes, with true curve lines and angles. Provide necessary rebates, lugs and brackets for assembly of units. Use concealed fasteners whenever and wherever possible.

- C. Shop fabricate so far as practicable. Joints fastened flush to conceal reinforcement, or welded where thickness or section permits.
- D. Contact surfaces of connected members be true. Assembled so joints will be tight and practically unnoticeable, without use of filling compound.
- E. Signs shall have fine, even texture and be flat and sound. Lines and miters sharp, arises unbroken, profiles accurate and ornament true to pattern. Plane surfaces be smooth flat and without oil-canning, free of rack and twist. Maximum variation from plane of surface plus or minus 0.3 mm (0.015 inches). Restore texture to filed or cut areas.
- F. Level or straighten wrought work. Members shall have sharp lines and angles and smooth surfaces.
- G. Extruded members to be free from extrusion marks. Square turns and corners sharp, curves true.
- H. Drill holes for bolts and screws. Conceal fastenings where possible. Exposed ends and edges mill smooth, with corners slightly rounded. Form joints exposed to weather to exclude water.
- I. Finish hollow signs with matching material on all faces, tops, bottoms and ends. Edge joints tightly mitered to give appearance of solid material.
- J. All painted surfaces properly primed. Finish coating of paint to have complete coverage with no light or thin applications allowing substrate or primer to show. Finished surface smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter and other imperfections.
- K. Movable parts, including hardware, are to be cleaned and adjusted to operate as designed without binding or deformation of members. Doors and covers centered in opening or frame. All contact surfaces fit tight and even without forcing or warping components.
- L. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- M. No signs are to be manufactured until final sign message schedule and location review has been completed by the Resident Engineer & forwarded to contractor.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Protect products against damage during field handling and installation. Protect adjacent existing and newly placed construction, landscaping and finishes as necessary to prevent damage during installation. Paint and touch up any exposed fasteners and connecting hardware to match color and

finish of surrounding surface.

- B. Mount signs in proper alignment, level and plumb according to the sign location plan and the dimensions given on elevation and sign location drawings. Where otherwise not dimensioned, signs shall be installed where best suited to provide a consistent appearance throughout the project. When exact position, angle, height or location is in doubt, contact Resident Engineer for clarification.
- C. Contractor shall be responsible for all signs that are damaged, lost or stolen while materials are on the job site and up until the completion and final acceptance of the job.
- D. Remove or correct signs or installation work Resident Engineer determines as unsafe or as an unsafe condition.
- E. At completion of sign installation, clean exposed sign surfaces. Clean and repair any adjoining surfaces and landscaping that became soiled or damaged as a result of installation of signs.
- F. Locate signs as shown on the Sign Location Plans.
- G. Certain signs may be installed on glass. A blank glass back up is required to be placed on opposite side of glass exactly behind sign being installed. This blank glass back up is to be the same size as sign being installed.
- H. Contractor will be responsible for verifying that behind each sign location there are no utility lines that will be affected by installation of signs. Any damage during installation of signs to utilities will be the sole responsibility of the Contractor to correct and repair.
- I. Furnish inserts and anchoring devices which must be set in concrete or other material for installation of signs. Provide setting drawings, templates, instructions and directions for installation of anchorage devices which may involve other trades.

- - - E N D - - -



**VA Palo Alto  
CO-GEN Building 610**

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**Sign Schedule**

Sign Summary - Code - Room-by-Room

**For Bid**

01 FEB 2013



**Kate Keating Associates, Inc.**  
Environmental & Graphic  
Design Consultants

1045 Sansome Street, Suite 202  
San Francisco, CA  
Tel: 415.773.1000  
Fax: 415.773.1008

GENERAL NOTES:

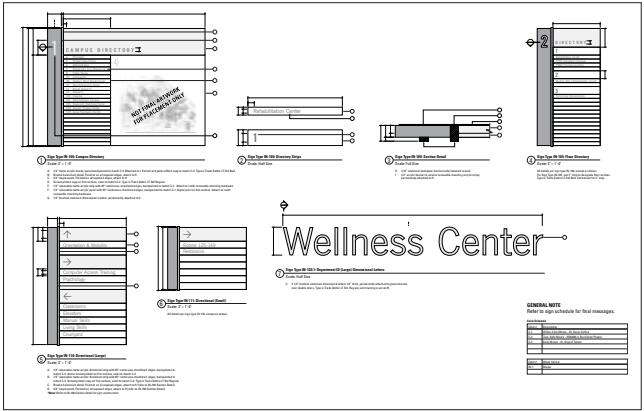
1. Refer to sign location plans for the location of each sign in the building. Wayfinding and Code signs have markers on location plans. For room identification signs, refer to the architectural room number centered in each room or area on sign location plans. Wayfinding and Code required signs on location plans are annotated with these symbols:



2. Refer to sign schedule by sign number or room number for final sign types, quantities and messages.

VA Palo Alto Recreation Services - Package 4						Issue Date: 4 AUGUST 2011		
Signage Program: 100% DD2								
Code/ WFL	Room Room	Sign Number	Sign Type	Qty	Arrow	Message	Sheet	Notes
B	W	B054	IN-105	1		B DIRECTORY	AG1.1.0	
						B		
						Gymnasium		
						Locker Rooms		
						Vending		
						1		
						Conference		
						Recreation Services Offices		
						Running Track		
						2		
						Fitness		
						Green Roof		
						Restrooms		

3. See construction drawings for details on each sign type.



4. Elevations shown for coordination and reference. Final locations to be verified in the field.



<b>Sign Type</b>	<b>Quantity</b>
EN-06.05	3
IN-01.01.02	5
IN-01.31.1	5
IN-300.1	6
IN-300.2	4
IN-301	2
IN-302	1
IN-320.3	1
IN-323	1
<hr/>	
<b>Total Quantity</b>	28

Code/ WF/ Room	Level	Sign Number	Room Number	Sign Type	QTY	Arrow	Message	Sheet	Notes
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## ***Interior Signage***

**NOTE:  
 INTERIOR SIGNS ARE  
 LOCATED IN 3 WAYS:**

### **W = WAYFINDING SIGN**

Located by:  
 SIGN NUMBER in this sign  
 schedule and corresponding  
 CIRCLE marker on sign location  
 plan.

### **C = CODE REQUIRED SIGN**

Located by:  
 SIGN NUMBER in this sign  
 schedule and corresponding  
 RECTANGLE marker on sign  
 location plan.

### **R = ROOM SIGN**

Located by:  
 ROOM NUMBER in this sign  
 schedule and corresponding  
 ARCHITECTURAL ROOM  
 NUMBER  
 on sign location plan, centered in  
 each room or area.

### **Level 1**

W	1	W1001		EN-06.05	1		Building 610 Co-Gen Building	AG1.1.1	Exterior sign.
W	1	W1003		EN-06.05	1		Building 610 Co-Gen Building	AG1.1.1	Exterior sign.

Code/ WF/ Room	Level	Sign Number	Room Number	Sign Type	QTY	Arrow	Message	Sheet	Notes
W	1	W1005		EN-06.05	1		Building 610 Co-Gen Building	AG1.1.1	Exterior sign.
<del>C</del>	<del>1</del>	<del>C1A01.1</del>	<del>1A01</del>	IN-300.1			<del>EXIT</del>	AG1.1.1	DELETE sign per background changes. 3/30/2012.
<del>C</del>	<del>1</del>	<del>C1A01.2</del>	<del>1A01</del>	IN-01.01.02			<del>(evacuation plan)</del>	AG1.1.1	DELETE sign per background changes. 3/30/2012.
C	1	C1A01.3	1A01	IN-01.01.02	1		(evacuation plan)	AG1.1.1	
C	1	C1A01.4	1A01	IN-300.1	1		EXIT	AG1.1.1	
C	1	C1A01.5	1A01	IN-01.31.1	1		(fire extinguisher symbol)	AG1.1.1	D/F Specific location TBD.
C	1	C1A01.6	1A01	IN-01.31.1	1		(fire extinguisher symbol)	AG1.1.1	D/F Specific location TBD.
C	1	C1A02.1	1A02	IN-300.1	1		EXIT	AG1.1.1	
C	1	C1A02.2	1A02	IN-01.01.02	1		(evacuation plan)	AG1.1.1	
C	1	C1A02.3	1A02	IN-300.1	1		EXIT	AG1.1.1	
C	1	C1A02.4	1A02	IN-01.01.02	1		(evacuation plan)	AG1.1.1	
C	1	C1A02.5	1A02	IN-300.2	1		1A02 ELECTRICAL	AG1.1.1	
C	1	C1A02.6	1A02	IN-300.2	1		1A02 ELECTRICAL	AG1.1.1	ADD sign per background changes. 3/30/2012.
C	1	C1A02.7	1A02	IN-01.31.1	1		(fire extinguisher symbol)	AG1.1.1	D/F Specific location TBD.

Code/ WF/ Room	Level	Sign Number	Room Number	Sign Type	QTY	Arrow	Message	Sheet	Notes
R	1	1A03	1A03	IN-302	1		1A03 (office ID insert holder)	AG1.1.1	List office occupant on printed insert.
R	1	1A04	1A04	IN-300.2	1		1A04 TELECOM ROOM	AG1.1.1	
R	1	1A05	1A05	IN-300.2	1		1A05 CONTROL ROOM	AG1.1.1	
C	1	C1A06.1	1A06	IN-320.3	1		1A06  (unisex symbol) STAFF ONLY	AG1.1.1	
C	1	C1A06.2	1A06	IN-323	1		(CA-T24 unisex door sign)	AG1.1.1	Door Mount.
R	1	1A07.1	1A07	IN-301	1		1A07 AMMONIA SCR ROOM	AG1.1.1	
C	1	C1A07.2	1A07	IN-300.1	1		EXIT	AG1.1.1	ADD sign per background changes. 3/30/2012.
C	1	C1A07.3	1A07	IN-01.01.02	1		(evacuation plan)	AG1.1.1	ADD sign per background changes. 3/30/2012.
C	1	C1A07.4	1A07	IN-01.31.1	1		(fire extinguisher symbol)	AG1.1.1	D/F Specific location TBD.
R	1	1A08.1	1A08	IN-301	1		1A08 GAS COMPRESSOR	AG1.1.1	
C	1	C1A08.2	1A08	IN-300.1	1		EXIT ROUTE	AG1.1.1	
C	1	C1A08.3	1A08	IN-300.1	1		EXIT	AG1.1.1	ADD sign per background changes. 3/30/2012.
C	1	C1A08.4	1A08	IN-01.01.02	1		(evacuation plan)	AG1.1.1	ADD sign per background changes. 3/30/2012.

Code/ WF/ Room	Level	Sign Number	Room Number	Sign Type	QTY	Arrow	Message	Sheet	Notes
C	1	C1A08.5	1A08	IN-01.31.1	1		<i>(fire extinguisher symbol)</i>	AG1.1.1	D/F Specific location TBD.



**SECTION 10 26 00**

**WALL AND DOOR PROTECTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies corner guards.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color and texture of aluminum and resilient material: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Corner Guards.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 DELIVERY AND STORAGE**

- A. Deliver materials to the site in original sealed packages or containers marked with the name and brand, or trademark of the manufacturer.
- B. Protect from damage from handling and construction operations before, during and after installation.

## **1.5 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. A167-99(R2009) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - 2. E84-09 Surface Burning Characteristics of Building Materials
- C. The National Association of Architectural Metal Manufacturers (NAAMM):
  - 1. AMP 500-06 Metal Finishes Manual
- D. Society of American Automotive Engineers (SAE):
  - 1. J 1545-05 Instrumental Color Difference Measurement for Exterior Finishes.
- E. Underwriters Laboratories Inc. (UL):
  - 1. Annual Issue Building Materials Directory

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Stainless Steel: ASTM A167, Type 302B.

### **2.2 CORNER GUARDS**

- A. Stainless Steel Corner Guards: Fabricate of 1.6 mm (0.0625-inch) thick stainless steel. Form guards of dimensions and to contour shown.

### **2.3 FINISH**

- A. In accordance with NAAMM AMP 500 series.
- B. Stainless Steel: NAAMM finish Number 4.

## **PART 3 - INSTALLATION**

### **3.1 STAINLESS STEEL CORNER GUARDS**

- A. Mount guards on external corners of interior walls, partitions and columns as shown.

### **3.2 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.



- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 10 28 00**

**TOILET, BATH, AND LAUNDRY ACCESSORIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies manufactured items usually used in toilets.
- B. Contractor furnished, Contractor installed (CC) toilet and bath accessories:
  - 1. Grab Bars.
  - 2. Metal framed mirror.
- C. Government furnished, Government installed (VV) toilet and bath accessories:
  - 1. Paper towel dispenser.
  - 2. Toilet tissue dispenser.
  - 3. Waste receptacle

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color of finishes: Section 09 06 00, SCHEDULE FOR FINISHES

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. Each product specified.
  - 2. Metal framed mirrors, showing shelf where required, fillers, and design and installation of units when installed on ceramic tile wainscots and offset surfaces.
  - 3. Grab bars, showing design and each different type of anchorage.
- C. Samples:
  - 1. One of each type of accessory specified.
  - 2. After approval, samples may be used in the work.

- D. Manufacturer's Literature and Data:
  - 1. All accessories specified.
  - 2. Show type of material, gages or metal thickness in inches, finishes, and when required, capacity of accessories.
  - 3. Show working operations of spindle for toilet tissue dispensers.
- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 QUALITY ASSURANCE**

- A. Each product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.
- B. Each accessory shall be assembled to the greatest extent possible before delivery to the site.
- C. Include additional features, which are not specifically prohibited by this specification, but which are a part of the manufacturer's standard commercial product.

#### **1.5 PACKAGING AND DELIVERY**

- A. Pack accessories individually to protect finish.
- B. Deliver accessories to the project only when installation work in rooms is ready to receive them.
- C. Deliver inserts and rough-in frames to site at appropriate time for building-in.
- D. Deliver products to site in sealed packages of containers; labeled for identification with manufacturer's name, brand, and contents.

#### **1.6 STORAGE**

- A. Store products in weathertight and dry storage facility.
- B. Protect from damage from handling, weather and construction operations before, during and after installation in accordance with manufacturer's instructions.

## **1.7 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A167-99(R2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
  2. A176-99(R2004) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
  3. A269-07 Seamless and Welded Austenitic Stainless Steel Tubing for General Service
  4. A312/A312M-06 Seamless and Welded Austenitic Stainless Steel Pipes
  5. B221-06 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  6. C1036-06 Flat Glass
  7. F446-85 (R2004) Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.
- C. The National Association of Architectural Metal Manufacturers (NAAMM):
1. AMP 500 Series Metal Finishes Manual
  2. AMP 500-505-88 Metal Finishes Manual and Finishes for Stainless Steel
- D. American Welding Society (AWS):
1. D10.4-86 (R2000) Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
- E. Federal Specifications (Fed. Specs.):
1. A-A-3002 Mirrors, Glass
  2. FF-S-107C (2) Screw, Tapping and Drive
  3. FF-S-107C Screw, Tapping and Drive.
  4. WW-P-541E(1) Plumbing Fixtures (Accessories, Land Use) Detail Specification

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Stainless Steel:
1. Plate or sheet: ASTM A167, Type 302, 304, or 304L, except ASTM A176 where Type 430 is specified, 0.0299-inch thick unless otherwise specified.

2. Tube: ASTM A269, Alloy Type 302, 304, or 304L.

B. Stainless Steel Tubing: ASTM A269, Grade 304 or 304L, seamless or welded.

C. Stainless Steel Pipe: ASTM A312; Grade TP 304 or TP 304L.

D. Glass:

1. ASTM C1036, Type 1, Class 1, Quality q2, for mirrors, and for mirror doors in medicine cabinets.

## **2.2 FASTENERS**

A. Concealed Fasteners: Steel, hot-dip galvanized (except in high moisture areas such as showers or bath tubs use stainless steel).

## **2.3 FINISH**

A. In accordance with NAAMM AMP 500 series.

B. AA-M32: Mechanical finish, medium satin.

1. Chromium Plating: ASTM B456, satin or bright as specified, Service Condition No. SC2.

2. Stainless Steel: NAAMM AMP 503, finish number 4.

## **2.4 FABRICATION - GENERAL**

A. Welding, AWS D10.4.

B. Grind dress, and finish welded joints to match finish of adjacent surface.

C. Form exposed surfaces from one sheet of stock, free of joints.

D. Provide steel anchors and components required for secure installation.

E. Form flat surfaces without distortion. Keep exposed surfaces free from scratches and dents. Reinforce doors to prevent warp or twist.

F. Shop assemble accessories and package with all components, anchors, fittings, fasteners and keys.

G. Key items alike.

H. Provide templates and rough-in measurements as required.

I. Round and deburr edges of sheets to remove sharp edges.

## **2.5 GRAB BARS**

A. Fed. Spec WW-P-541/8B, Type IV, bars, surface mounted, Class 2, grab bars and ASTM F446.

- B. Fabricate of either stainless steel or nylon coated steel, except use only one type throughout the project:
  - 1. Stainless steel: Grab bars, flanges, mounting plates, supports, screws, bolts, and exposed nuts and washers.
- C. Concealed mount.
- D. Bars:
  - 1. Fabricate from 38 mm (1-1/2 inch) outside diameter tubing.
    - a. Stainless steel, minimum 1.2 mm (0.0478 inch) thick.
  - 2. Fabricate in one continuous piece with ends turned toward walls, except swing up and where grab bars are shown continuous around three sides of showers, bars may be fabricated in two sections, with concealed slip joint between.
  - 3. Continuous weld intermediate support to the grab bar.
- E. Flange for Concealed Mounting:
  - 1. Minimum of 2.65 mm (0.1046 inch) thick, approximately 75 mm (3 inch) diameter by 13 mm (1/2 inch) deep, with provisions for not less than three set screws for securing flange to back plate.
  - 2. Insert grab bar through center of the flange and continuously weld perimeter of grab bar flush to back side of flange.
- F. Back Plates:
  - 1. Minimum 2.65 mm (0.1046 inch) thick metal.
  - 2. Fabricate in one piece, approximately 6 mm (1/4 inch) deep, with diameter sized to fit flange. Provide slotted holes to accommodate anchor bolts.

## **2.6 METAL FRAMED MIRRORS**

- A. Spec. A-A-3002 metal frame; anodized aluminum or stainless steel, type 302 or 304.
- B. Mirror Glass:
  - 1. Minimum 6 mm (1/4 inch) thick.
  - 2. Set mirror in a protective vinyl glazing tape.
  - 3. Use tempered glass for mirrors in Mental Health and Behavioral Nursing units.
- C. Frames:
  - 1. Channel or angle shaped section with face of frame not less than 9 mm (3/8 inch) wide. Fabricate with square corners.
  - 2. Use either 0.9 mm (0.0359 inch) thick stainless steel, chrome finished steel, or extruded aluminum, with clear anodized finish 0.4 mils thick.

3. Filler:

- a. Where mirrors are mounted on walls having ceramic tile wainscots not flush with wall above, provide fillers at void between back of mirror and wall surface.
- b. Fabricate fillers from same material and finish as the mirror frame, contoured to conceal the void behind the mirror at sides and top.

**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Before starting work notify Resident Engineer in writing of any conflicts detrimental to installation or operation of units.
- B. Verify with the Resident Engineer the exact location of accessories.

**3.2 INSTALLATION**

- A. Set work accurately, in alignment and where shown. Items shall be plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Install accessories in accordance with the manufacturer's printed instructions and ASTM F446.
- C. Install accessories plumb and level and securely anchor to substrate.
- D. Install accessories in a manner that will permit the accessory to function as designed and allow for servicing as required without hampering or hindering the performance of other devices.
- E. Install accessories to prevent striking by other moving, items or interference with accessibility.

**3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

**3.4 CLEANING**

- A. After installation, clean as recommended by the manufacturer and protect from damage until completion of the project.

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**SECTION 10 44 13.13**

**FIRE EXTINGUISHER MOUNTING BRACKETS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section covers fire extinguisher mounting brackets for Government supplied portable fire extinguishers.

**1.2 SUBMITTALS**

- A. Manufacturer's Literature and Data: Fire extinguisher cabinet including installation instruction and rough opening required.
- B. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**PART 2 - PRODUCTS**

**2.1 FIRE EXTINGUISHER MOUNTING BRACKETS**

- A. Manufacturer's standard steel mounting bracket, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

**PART 3 - EXECUTION**

- A. Install fire extinguisher mounting brackets and secure in accordance with manufacturer's instructions.
- B. Install fire extinguisher mounting brackets so that bottom of fire extinguisher is 975 mm (39 inches) above finished floor.

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**SECTION 12 24 00**

**WINDOW SHADES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Manually operated roller shades are specified in this section. Manually operated roller shades shall be furnished complete, including brackets, fittings and hardware.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS - RADIOLOGY CONSOLIDATION.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Color of shade cloth: Section 09 06 00, SCHEDULE FOR FINISHES.
- D. Section 09 29 00 - Gypsum Board: Coordination with gypsum board for installation of shade housing, closures and related accessories.
- E. Section 09 51 00 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade housing, closures and related accessories.

**1.3 QUALITY CONTROL**

- A. Installer Qualifications: Fabricator of products.
- B. Source Limitations: Obtain roller shades through one source from a single manufacturer.
- C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to the Government:
  - 1. Flame-Resistance Ratings: Passes NFPA 701.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
  - 1. Shade cloth, each type, 600 mm (24 inch) square, including cord and ring, showing color, finish and texture.

- C. Manufacturer's literature and data; showing details of construction and hardware for:
  - 1. Cloth and window shades
- D. LEED Submittals: Submit in accordance with Section 01 81 11.02.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced to in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. A167-99 (R2004) Stainless and heat-Resisting Chromium- Nickel Steel Plate, Sheet and Strip
  - 2. B221/B221M-07 Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- C. National Fire Protection Association (NFPA):
  - 1. 701-04 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

#### **1.6 WARRANTY**

- A. Roller window shades are subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period shall be extended as follows from date of final acceptance of project by Government:
  - 1. Manual roller shade hardware: Eight years, except for bead and chain, which is considered a maintenance item.
  - 2. Shade cloth: Ten years.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Shade Cloth: Roller shade manufacturer's shade cloth material with anti-microbial properties that do not support growth of microorganisms, and complies with NFPA 701; types and properties as follows:
  - 1. Light-Filtering Shade Cloth:
    - a. Openess Factor: Three percent.

- b. Type: 100 percent thermoplastic olefin (TPO) yarn.
- c. Weave: Basket-weave pattern.
- d. Thickness: Manufacturer's standard.
- e. Color: Refer to Section 09 06 00, SCHEDULE FOR FINISHES.

B. Stainless Steel: ASTM A167

C. Extruded Aluminum: ASTM B221/B221M.

D. Loop bead-chain: Stainless steel, minimum 41 kg (90 lbs) tensile strength; with length for full length of roller shade; Provide upper and lower ball stops.

## 2.2 FASTENINGS

A. Zinc-coated or cadmium plated metal, aluminum or stainless steel fastenings of proper length and type. Except as otherwise specified, fastenings for use with various structural materials shall be as follows:

<u>Type of Fastening</u>	<u>Structural Material</u>
1. Case-hardened, self-tapping screw	Sheet Metal

## 2.3 FABRICATION

A. Fabricate roller shades to fit measurements of finished openings obtained at site.

- 1. Roller window shade types:
  - a. Single; with light-filtering shade cloth.

B. Shade Band: Rolling type, constructed of shade cloth mounted on rollers. Shade cloth shall have heat-sealed trimmed edges, and with hem at bottom to accommodate hem weight to allow the shade cloth to hang straight without curling or raveling. Separate shades are required for each individual sash within opening. Length and width of shades shall fill window openings from head to sill and jamb-to-jamb.

- 1. Provide extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
- 2. Provide chain-and-clutch operating mechanism with continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated
- 3. Provide manufacturer's standard removable spline fitting integral channel in tube for attaching shade material.

C. Mounting Hardware: Provide brackets that are corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

- D. Roller Shade Pocket: Rectangular extruded aluminum ceiling pocket mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes. Provide bottom removable closure and closure mount.
- E. Mounting Brackets: Fabricate from galvanized or zinc-plated steel.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.
- B. Shade installation methods not specifically described, are subject to approval of Resident Engineer.

#### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 12 93 00**

**SITE FURNISHINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Furnish and install all site furnishings shown on drawings and specified in accordance with the manufacturer's instructions and as shown on the drawings and as specified, including benches.
- B. Related requirement specifications elsewhere:
  - 1. Section 32 05 23 Cement and Concrete for Exterior Improvements
  - 2. Section 32 13 20 Site Concrete
  - 3. Section 32 90 00 Planting

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

**1.3 REFERENCES:**

- A. Perform work in accordance with all applicable laws, codes and regulations required by the City and the State of California.
- B. Manufacturer's Instructions: Where required in the Specifications that materials, products, processes, equipment or the like to be installed or applied in accordance with manufacturer's instructions, directions or specifications, or words to this effect, it shall be constructed to mean that said application or installation shall be in strict accordance with printed instructions furnished by the manufacturer of the material for use under conditions similar to those at the job site.
- C. Reference Standards:
  - 1. State of California, Business and Transportation Agency, Department of Transportation: CALTRANS Standard Specifications.
  - 2. Manufacturers' specifications and recommendations.

**1.4 COORDINATION:**

- A. Coordinate items of other trades. Contractor shall be responsible for the proper installation of all accessories embedded in concrete and for the provision of connections, holes, openings, etc., necessary to the execution of the work of the trades.

**1.5 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Bike Rack as shown on Drawings
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**PART 2 - PRODUCTS**

**2.1 BIKE RACK**

- A. As shown on Drawings.

**PART 3 - EXECUTION**

**3.1 GENERAL INSTALLATION:**

- A. Install manufactured items in accordance with the manufacturer's instruction and as shown in the drawings and as specified herein.
- B. Perform all work in accordance with all applicable laws, codes and regulations required by State of California and the City of Palo Alto.
- C. Set all work true and square, plumb and level. Remove and replace any wood that splits during or after erection until acceptance.
- D. Galvanized metal that is cut, damaged or modified after fabrication shall be immediately painted with Zinc-rich paint to prevent rusting.
- E. Touch up paint any damaged surfaces to match original finish as accepted by Owner's Representative.
- F. Set site furniture, level. Provide spacers under furniture to level as acceptable to Owner's Representative
- G. Transport, store and handle precast units and manufactured items in a manner to avoid hairline cracks, staining or other damage. Store units free of the ground and protected from mud or rain splashes. Cover units, secure



covers firmly, and protect the units from dust, dirt or other staining material.

**3.2 BIKE RACK:**

- A. Install in accordance with the manufacturer's instruction and as shown.

**3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 13 05 41**

**SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Provide gravity and seismic restraint in accordance with the requirements of this section in order to maintain the integrity of nonstructural components of the building and utility structures so that they remain safe and functional in case of seismic event.
- B. Definitions: Non-structural components are components or systems that are not part of the building's or utility structures' structural system whether inside or outside, above or below grade. Non-structural components include:
  - 1. Architectural Elements: Facades that are not part of the structural system and its shear resistant elements; exterior wall framing; cornices and other architectural projections and parapets that do not function structurally; glazing; nonbearing partitions; suspended ceilings; stairs isolated from the basic structure; cabinets; bookshelves; medical equipment; and storage racks.
  - 2. Electrical Elements: Power and lighting systems; power equipment center, substations; switchgear and switchboards; auxiliary engine-generator sets; transfer switches; motor control centers; motor generators; selector and controller panels; fire protection and alarm systems; special life support systems; and telephone and communication systems.
  - 3. Mechanical Elements: Heating, ventilating, and air-conditioning systems; medical gas systems; plumbing systems; sprinkler systems; steam piping; chilled water piping; pneumatic systems; boiler equipment and components.
  - 4. Transportation Elements: Mechanical, electrical and structural elements for transport systems, i.e., elevators and dumbwaiters, including hoisting equipment and counterweights.

**1.2 RELATED WORK:**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Refer to all other divisions contained in these specifications for information related to the non-structural components defined above.

**1.3 QUALITY CONTROL:**

A. Shop-Drawing Preparation:

1. Have gravity support and seismic-force-restraint shop drawings and calculations prepared by a professional structural engineer experienced in the area of seismic force restraints. The professional structural engineer shall be registered in the state of California.
2. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in the State of California.

B. Coordination:

1. Do not install gravity supports or seismic restraints until approved by the Resident Engineer.
2. Coordinate and install trapezes or other multi-pipe hanger systems prior to pipe installation.

**1.4 SUBMITTALS:**

A. Submit a coordinated set of equipment anchorage drawings prior to installation including:

1. Description, layout, and location of items to be anchored or braced with anchorage or brace points noted and dimensioned.
2. Details of anchorage or bracing at large scale with all members, parts brackets shown, together with all connections, bolts, welds etc. clearly identified and specified.
3. Numerical value of design seismic brace loads.
4. For expansion bolts, include design load and capacity if different from those specified. Provide current ICC-ES reports for anchors showing compliance with referenced codes and approved for use in cracked concrete (seismic). Refer to Section 05 12 00 STRUCTURAL STEEL FRAMING for additional wedge anchor criteria.
5. Seal of registered structural engineer responsible for design.

B. Submit prior to installation, a coordinated set of bracing drawings for seismic protection of piping, with data identifying the various support-to-structure connections and seismic bracing structural connections, include:

1. Single-line piping diagrams on a floor-by-floor basis. Show all suspended piping for a given floor on the same plain.
2. Type of pipe (Copper, steel, cast iron, insulated, non-insulated, etc.).
3. Pipe contents.
4. Structural framing.
5. Location of all gravity load pipe supports and spacing requirements.
6. Numerical value of gravity load reactions.

7. Location of all seismic bracing.
  8. Numerical value of applied seismic brace loads.
  9. Type of connection (Vertical support, vertical support with seismic brace etc.).
  10. Seismic brace reaction type (tension or compression). Details illustrating all support and bracing components, methods of connections, and specific anchors to be used.
  11. Seal of registered engineer responsible for design.
- C. Submit prior to installation, bracing drawings for seismic protection of suspended ductwork and suspended electrical and communication cables, include:
1. Details illustrating all support and bracing components, methods of connection, and specific anchors to be used.
  2. Numerical value of applied gravity and seismic loads and seismic loads acting on support and bracing components.
  3. Maximum spacing of hangers and bracing.
  4. Seal of registered structural engineer responsible for design.
- D. Submit structural design bracing and anchorage calculations and details for all non-structural components identified in this specification, prepared and sealed by the registered structural engineer specified above in paragraph 1.3A.
- E. Submit for concrete anchors, the appropriate ICC evaluation reports, OSHPD pre- approvals, or lab test reports verifying compliance with OSHPD Interpretation of Regulations 28-6.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS:**

- A. The Publications listed below (including amendments, addenda revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only.
- B. American Concrete Institute (ACI):
1. 355.2-07 Qualification for Post-Installed Mechanical Anchors in Concrete and Commentary

2. 318-05 Building Code Requirements for Structural Concrete and Commentary.
- C. American Institute of Steel Construction (AISC):
  1. Load and Resistance Factor Design, Volume 1, Second Edition.
- D. American Society for Testing and Materials (ASTM):
  1. A36/A36M-05 Standard Specification for Carbon Structural Steel.
  2. A53/A53M-07 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  3. A307 (REV A-07) Standard Specification for Carbon Steel Bolts and Studs; 60,000 PSI Tensile Strength.
  4. A325-07 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
  5. A325M-05 Standard Specification for High-Strength Bolts for Structural Steel Joints [Metric].
  6. A490-06 Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
  7. A490M (REV A-04) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric].
  8. A500/A500M-07 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
  9. A501-07 Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
  10. A615/A615M-07 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  11. A992/A992M (REV A-06) Standard Specification for Steel for Structural Shapes for Use in Building Framing.
  12. A996/A996M (REV A-06) Standard Specification for Rail-Steel and Axel-Steel Deformed Bars for Concrete Reinforcement.
  13. E488-96 (R2003) Standard Test Method for Strength of Anchors in Concrete and Masonry Elements.
- E. International Building Code (IBC) 2009 Edition.
- F. VA Seismic Design Requirements, H-18-8, current edition.
- G. National Uniform Seismic Installation Guidelines (NUSIG).
- H. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  1. Seismic Restraint Manual - Guidelines for Mechanical Systems, 1998 Edition and Addendum.

## **1.6 REGULATORY REQUIREMENT:**

- A. IBC 2009.  $I = 1.5$  for all structures, unless otherwise noted on the drawings. See the structural drawings for seismic design criteria and the required seismic design category.
- B. Short-period acceleration,  $S_{DS}$ , for use in calculation of seismic anchorage and bracing forces as required by the IBC, shall be taken as for that cited for the project location in VA document H-18-8.
- C. Exceptions: The seismic restraint of the following items may be omitted:
  - 1. Equipment weighing less than 400 pounds, which is supported directly on the floor or roof.
  - 2. Equipment weighing less than 20 pounds, which is suspended from the roof or floor or hung from a wall.
  - 3. Gas and medical piping less than 2 1/2 inches inside diameter.
  - 4. Piping in boiler plants and equipment rooms less than 1 1/4 inches inside diameter.
  - 5. All other piping less than 2 1/2 inches inside diameter, except for automatic fire suppression systems.
  - 6. All piping suspended by individual hangers, 12 inches or less in length from the top of pipe to the bottom of the support for the hanger.
  - 7. All electrical conduits, less than 2 1/2 inches inside diameter.
  - 8. All rectangular air handling ducts less than six square feet in cross sectional area.
  - 9. All round air handling ducts less than 28 inches in diameter.
  - 10. All ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of support for the hanger.
- D. Seismic Certification: Permanent equipment and components are to have Special Seismic Certification in accordance with ASCE 7-05 and as clarified in the Office of Statewide Health Planning and Development (OSHPD) Code Application Notice (CAN) No. 2-1708A.5.

## **PART 2 - PRODUCTS**

### **2.1 STEEL:**

- A. Structural Steel: ASTM A36.
- B. Structural Tubing: ASTM A500, Grade B.
- C. Steel Pipe: ASTM A53/A53M, Grade B.
- D. Bolts & Nuts: ASTM **A307**.

**2.2 CAST-IN-PLACE CONCRETE:**

- A. Concrete: 28 day strength,  $f'c = 30$  MPa (4,000 psi).
- B. Reinforcing Steel: ASTM A615/615M or ASTM A996/A996M deformed.

**PART 3 - EXECUTION**

**3.1 CONSTRUCTION, GENERAL:**

- A. Provide equipment supports and anchoring devices to withstand the seismic and gravity design forces, so that when seismic design forces are applied, the equipment cannot displace, overturn, or become inoperable.
- B. Provide anchorages in conformance with recommendations of the equipment manufacturer and as shown on approved shop drawings and calculations.
- C. Construct seismic restraints and anchorage to allow for thermal expansion.
- D. Testing Before Final Inspection:
  - 1. Test 10-percent of anchors in concrete per ASTM E488, and ACI 355.2 to determine that they meet the required load capacity. If any anchor fails to meet the required load, test the next 20 consecutive anchors, which are required to have zero failure, before resuming the 10-percent testing frequency.
  - 2. Before scheduling Final Inspection, submit a report on this testing indicating the number and location of testing, and what anchor-loads were obtained.
- E. Anchorage, bracing and connection details shown on the drawings indicate the general design intent. The final anchorage and bracing design for non-structural components is to be determined by the registered structural engineer specified above in paragraph 1.3A.

**3.2 EQUIPMENT RESTRAINT AND BRACING:**

- A. See drawings for equipment to be restrained or braced.

**3.3 MECHANICAL DUCTWORK AND PIPING; STEAM AND CHILLED WATER PIPING; BOILER PLANT STACKS AND BREACHING; ELECTRICAL BUSWAYS, CONDUITS, AND CABLE TRAYS; AND TELECOMMUNICATION WIRES AND CABLE TRAYS**

- A. Support and brace mechanical ductwork and piping; electrical busways, conduits and cable trays; and telecommunication wires and cable trays including boiler plant stacks and breeching to resist directional forces (lateral, longitudinal and vertical).
- B. Brace duct and breeching branches with a minimum of 1 brace per branch.
- C. Provide supports and anchoring so that, upon application of seismic forces, piping remains fully connected as operable systems which will not displace



sufficiently to damage adjacent or connecting equipment, or building members.

D. Seismic Restraint of Piping:

1. Design criteria:

- a. IBC 2009 seismic criteria.
- b. VA H18-8 Seismic Design Requirements.
- c. See the structural drawings for additional seismic design criteria.

E. Piping Connections: Provide flexible connections where pipes connect to equipment. Make the connections capable of accommodating relative differential movements between the pipe and equipment under conditions of earthquake shaking.

### **3.4 PARTITIONS**

A. In buildings with flexible structural frames, anchor partitions to only structural element, such as a floor slab, and separate such partition by a physical gap from all other structural elements.

### **3.5 CEILINGS AND LIGHTING FIXTURES**

A. At regular intervals, laterally brace suspended ceilings against lateral and vertical movements, and provide with a physical separation at the walls. Lateral bracing of ceilings it to comply with all applicable code requirements for the specified seismic design category.

B. Independently support and laterally brace all lighting fixtures. Refer to applicable portion of lighting specification, Section 26 51 00, INTERIOR LIGHTING.

### **3.6 FACADES AND GLAZING**

A. Do not install concrete masonry unit filler walls in a manner that can restrain the lateral deflection of the building frame. Provide a gap with adequately sized resilient filler to separate the structural frame from the non-structural filler wall.

B. Tie brick veneers to a separate wall that is independent of the steel frame as shown on construction drawings to ensure strength against applicable seismic forces at the project location.

C. Install attachments to structure for all façade materials as shown on construction drawings to ensure strength against applicable seismic forces at the project location.

### **3.7 STORAGE RACKS, CABINETS, AND BOOKCASES**

A. Install storage racks to withstand earthquake forces and anchored to the floor or laterally braced from the top to the structural elements.

- B. Anchor medical supply cabinets to the floor or walls and equip them with properly engaged, lockable latches.
- C. Anchor filing cabinets that are more than 2 drawers high to the floor or walls, and equip all drawers with properly engaged, lockable latches.
- D. Anchor bookcases that are more than 30 inches high to the floor or walls, and equip any doors with properly engaged, lockable latches.

### **3.8 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -

**SECTION 21 05 11**

**COMMON WORK RESULTS FOR FIRE SUPPRESSION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 21.
- B. Definitions:
  - 1. Exposed: Piping and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 01 00 00, GENERAL REQUIREMENTS.
- D. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- E. Excavation and Backfill: Section 31 20 00, EARTH MOVING.
- F. Concrete and Grout: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- G. Building Components for Attachment of Hangers: Section 05 36 00, COMPOSITE METAL DECKING.
- H. Section 05 50 00, METAL FABRICATIONS.
- I. Section 07 84 00, FIRESTOPPING.
- J. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- K. Section 07 92 00, JOINT SEALANTS.
- L. Section 09 91 00, PAINTING.
- M. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- N. Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS
- O. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

P. Section 28 31 00, FIRE DETECTION AND ALARM

### **1.3 QUALITY ASSURANCE**

A. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and is located reasonably close to the site.
3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
5. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
6. Asbestos products or equipment or materials containing asbestos shall not be used.

B. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

C. Guaranty: GENERAL CONDITIONS.

D. Supports for sprinkler piping shall be in conformance with NFPA 13.

### **1.4 SUBMITTALS**

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.

1. Equipment and materials identification.
2. Fire-stopping materials.
3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
4. Wall, floor, and ceiling plates.

- C. Coordination Drawings: Provide detailed layout drawings of all piping systems. In addition, provide - details of the following.
  - 1. Mechanical equipment rooms.
  - 2. Interstitial space.
  - 3. Hangers, inserts, supports, and bracing.
  - 4. Pipe sleeves.
  - 5. Equipment penetrations of floors, walls, ceilings, or roofs.
- D. Maintenance Data and Operating Instructions:
  - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  - 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment.
- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
  - 1. A36/A36M-2001 Carbon Structural Steel
  - 2. A575-96 Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
  - 3. E84-2003 Standard Test Method for Burning Characteristics of Building Materials
  - 4. E119-2000 Standard Test Method for Fire Tests of Building Construction and Materials
- C. National Fire Protection Association (NFPA):
  - 1. 90A-96 Installation of Air Conditioning and Ventilating Systems
  - 2. 101-99 Life Safety Code

## **PART 2 - PRODUCTS**

### **2.1 LIFTING ATTACHMENTS**

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

### **2.2 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- C. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- D. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- E. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- F. Valve Tags and Lists:
  - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
  - 3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

### **2.3 FIRESTOPPING**

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping.

## **2.4 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint form.

## **2.5 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.6 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- D. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

## **2.7 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs



during installation. Tightly cover and protect equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly exposed materials and equipment.

- C. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Install gages, valves, and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- E. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.
- F. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
  - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

### **3.2 LUBRICATION**

- A. Field check and lubricate equipment requiring lubrication prior to initial operation.

### **3.3 STARTUP AND TEMPORARY OPERATION**

- A. Start up equipment as described in equipment specifications. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.4 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

**3.5 INSTRUCTIONS TO VA PERSONNEL**

- A. Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

**3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 21 13 13**

**WET-PIPE SPRINKLER SYSTEMS**

**PART 1 - GENERAL**

**1.1 SCOPE OF WORK**

- A. Design, installation and testing shall be in accordance with
  - 1. NFPA 13 except for specified exceptions.
- B. The design and installation of a hydraulically calculated automatic wet system complete and ready for operation, for all portions of the Site Utility Building.

**1.2 RELATED WORK**

- A. Sustainable design requirements and procedures including submittal requirements: Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS.
- B. Procedures and requirements for managing and disposing construction and demolition waste: Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Section 33 10 00, WATER UTILITIES.
- E. Section 07 84 00, FIRESTOPPING, Treatment of penetrations through rated enclosures.
- F. Section 09 91 00, PAINTING.
- G. Section 28 31 00, FIRE DETECTION AND ALARM, Connection to fire alarm of flow switches, pressure switches and valve supervisory switches.
- H. Section 21 05 11 COMMON WORK RESULTS FOR FIRE SUPPRESSION

**1.3 QUALITY ASSURANCE**

- A. Installer Reliability: The installer shall possess a valid State of California fire sprinkler contractor's license. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.
- B. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA.
- C. Submittals: Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that

are signed by a NICET Level III or Level IV Sprinkler Technician or stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering. As Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably bind submittals in notebooks or binders and provide index referencing the appropriate specification section. Submittals shall include, but not be limited to, the following:

1. Qualifications:
  - a. Provide a copy of the installing contractor's fire sprinkler and state contractors license.
  - b. Provide a copy of the NICET certification for the NICET Level III or Level IV Sprinkler Technician who prepared and signed the detailed working drawings unless the drawings are stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering.
2. Drawings: Submit detailed 1:100 (1/8 inch) scale (minimum) working drawings conforming to NFPA 13. Include a site plan showing the piping to the water supply test location.
3. Manufacturers Data Sheets:
  - a. For backflow preventers (to be provided by Civil), provide flow test curves from UL, FM, or the Foundation for Hydraulic Research and Cross-Connection Control to verify pressure loss calculations.
  - b. Provide for materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.
4. Calculation Sheets: Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of NFPA 13.
5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals shall include, but not be limited to, the following:
  - a. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the waterflow switch or pressure switch and the fire alarm equipment.
  - b. Complete, simple, understandable, step-by-step, testing instructions giving recommended and required testing frequency of all equipment, methods for testing all equipment, and a complete trouble shooting manual. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components with information as to the address and telephone number of both the manufacturer and the local supplier of each item.

- c. Material and Testing Certificate: Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13.
  - d. Certificates shall document all parts of the installation.
  - e. Instruction Manual: Provide one copy of the instruction manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser.
- D. Design Basis Information: Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13. Recommendations in appendices shall be treated as requirements.
  - 1. Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method. Do not restrict design area reductions permitted for using quick response sprinklers throughout by the required use of standard response sprinklers in the areas identified in this section.
  - 2. Sprinkler Protection: To determining spacing and sizing, apply the following coverage classifications:
    - a. Light Hazard Occupancies: Office and similar areas.
    - b. Extra Hazard Group 1 Occupancies: Machinery Spaces
    - c. Request clarification from the Government for any hazard classification not identified.
  - 3. Hydraulic Calculations: Calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
  - 4. Water Supply: Base water supply on a flow test of the following. A safety factor shall be included by calculating the demand to a point no greater than 10% below the available water supply curve:
    - a. Location Fire Hydrant #7
    - b. Elevation Static Test Gauge Unknown
    - c. Elevation Residual Test Gauge Unknown
    - d. Static pressure: 85 psi
    - e. Residual pressure: 75 psi
    - f. Flow: 1,063 gpm
    - g. Date: February 24, 2009 Time 1:50 pm
  - 5. Zoning:
    - a. For each sprinkler zone provide a control valve, flow switch and a test and drain assembly with pressure gauge.
    - b. Sprinkler zones shall conform to the smoke barrier zones shown on the drawings.
    - c. Provide seismic protection in accordance with NFPA 13.

#### **1.4 SUBMITTALS**

- A. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
  - 1. 13-2007 Installation of Sprinkler Systems
  - 2. 101-2009 Safety to Life from Fire in Buildings and Structures (Life Safety Code)
  - 3. 170-2006 Fire Safety Symbols
- C. Underwriters Laboratories, Inc. (UL):
- D. Fire Protection Equipment Directory - 2001
- E. Factory Mutual Engineering Corporation (FM):
  - 1. Approval Guide - Online Version
- F. Foundation for Cross-Connection Control and Hydraulic Research-2005

### **PART 2 - PRODUCTS**

#### **2.1 PIPING & FITTINGS**

- A. Sprinkler systems in accordance with NFPA 13. Use nonferrous piping in MRI Scanning Rooms.

#### **2.2 VALVES**

- A. Valves in accordance with NFPA 13.
- B. Do not use quarter turn ball valves for 2 inch or larger drain valves.
- C. The wet system control valve shall be a listed indicating type valve. Control valve shall be UL Listed and FM Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI. (No Substitutions Allowed).

- D. Alarm valve shall be UL Listed and Factory Mutual Approved. The alarm valve shall be equipped with a removable cover assembly. The alarm valve shall be listed for installation in the vertical or horizontal position. The alarm valve shall be equipped with gauge connections on the system side and supply side of the valve clapper. The alarm valve shall be equipped with an external bypass to eliminate false water flow alarms. The alarm valve trim piping shall be externally galvanized. Maximum water working pressure to 250 PSI.
- E. Automatic Ball Drips: Cast brass 20 mm (3/4 inch) in-line automatic ball drip with both ends threaded with iron pipe threads.

### **2.3 FIRE DEPARTMENT SIAMESE CONNECTION**

- A. (To be provided by Civil) Brass, exterior fire department connection with brass escutcheon plate, [**without sill cock,**] and a minimum of two 65 mm (2-1/2 inch) connections threaded to match those on the local fire protection service, with polished brass caps and chains. Provide escutcheon with integral raised letters "Automatic Sprinkler".

### **2.4 SPRINKLERS**

- A. All sprinklers except "institutional" type sprinklers shall be FM approved. Provide quick response sprinklers in all areas, except where specifically prohibited by their listing or approval.
  - 1. In generator rooms: Standard response sprinklers.
  - 2. (Note: Provide 'cages' to protect sprinkler heads from breakage/damage when the elevation of the head is less than 7 feet 6 inches above finished floor (mechanical rooms, janitor closets, etc).
- B. Temperature Ratings: In accordance with NFPA 13, except as follows:
  - 1. Sprinklers in Generator Rooms: High temperature rated.

### **2.5 SPRINKLER CABINET**

- A. Provide sprinkler cabinet with the required number of sprinkler heads of all ratings and types installed, and a sprinkler wrench for each system. Locate adjacent to the riser. Sprinkler heads shall be installed in center of tile or center to center.

### **2.6 IDENTIFICATION SIGNS/HYDRAULIC PLACARDS**

- A. Plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Enter pertinent data for each system on the hydraulic placard.

### **2.7 SWITCHES:**

- A. Contain in a weatherproof die cast/red baked enamel, oil resistant, aluminum housing with tamper resistant screws, 13 mm (1/2 inch) conduit entrance and necessary facilities for attachment to the valves. Provide two SPDT switches rated at 2.5 amps at 24 VDC.

- B. Water flow Alarm Switches: Mechanical, non-coded, non-accumulative retard and adjustable from 0 to 60 seconds minimum. Set flow switches at an initial setting between 20 and 30 seconds.
- C. Valve Supervisory Switches for Ball and Butterfly Valves: May be integral with the valve.

## **2.8 GAUGES**

- A. Provide gauges as required by NFPA 13.

## **2.9 PIPE HANGERS AND SUPPORTS**

- A. Supports, hangers, etc., of an approved pattern placement to conform to NFPA 13. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, Standard for Installation of Sprinkler Systems. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.

## **2.10 WALL, FLOOR AND CEILING PLATES**

- A. Provide chrome plated steel escutcheon plates for exposed piping passing through walls, floors or ceilings.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Install concealed piping in spaces that have finished ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. Locate piping in stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel, and to provide a minimum headroom clearance of 2250 mm (seven feet six inches). To prevent an obstruction to egress, provide piping clearances in accordance with NFPA 101.
- C. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains: Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct



drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13.

- E. Supervisory Switches: Provide supervisory switches for sprinkler control valves.
- F. Waterflow Alarm Switches: Install waterflow switch and adjacent valves in easily accessible locations.
- G. Inspector's Test Connection: Install and supply in conformance with NFPA 13, locate in a secured area, and discharge to the exterior of the building.
- H. Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- I. Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.
- J. Provide pressure gauge at each water flow alarm switch location and at each main drain connection.
- K. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- L. Securely attach identification signs to control valves, drain valves, and test valves. Locate hydraulic placard information signs at each sectional control valve where there is a zone water flow switch.
- M. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.

### **3.2 INSPECTION AND TEST**

- A. Preliminary Testing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed. Hydrostatically test system, including the fire department connections, as specified in NFPA 13, in the presence of the Contracting Officers Technical Representative (COTR) or his designated representative. Test and flush underground water line prior to performing these hydrostatic tests.
- B. Final Inspection and Testing: Subject system to tests in accordance with NFPA 13, and when all necessary corrections have been accomplished, advise COTR/Resident Engineer to schedule a final inspection and test. Connection to the fire alarm system shall have been in service for at least ten days prior to the final inspection, with adjustments made to prevent false alarms. Furnish all instruments, labor and materials required for the tests

and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct deficiencies and retest system as necessary, prior to the final acceptance. Include the operation of all features of the systems under normal operations in test.

### **3.3 INSTRUCTIONS**

- A. Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COTR/Resident Engineer.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 21 21 13.13**

**HIGH-PRESSURE CARBON-DIOXIDE FIRE-EXTINGUISHING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Carbon Dioxide (CO<sub>2</sub>) fire extinguishing system for use with the Combustion Turbine Generator.
- B. SECTION INCLUDES:
  - 1. Carbon dioxide.
  - 2. Piping.
  - 3. Flexible-hose connectors.
  - 4. Carbon-dioxide cylinders.
  - 5. Cylinder valves.
  - 6. Discharge nozzles.
  - 7. Hangers and supports.
  - 8. Control panels.
  - 9. Detection devices.
  - 10. Manual stations.
  - 11. Switches.
  - 12. Alarm devices.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.

**1.3 QUALITY ASSURANCE**

- A. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic

design that has a proven satisfactory service record of at least three years.

2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
  3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
  4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
  5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
  6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  8. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

4. All welds shall be stamped according to the provisions of the American Welding Society.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
  1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.
  2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- E. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- F. Plumbing Systems: IPC, International Plumbing Code.
- G. Seismic Requirements: See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Earthquake-resistive design shall comply with the referenced editions of the following:
  1. VA Handbook H-18-8, Seismic Design Requirements
  2. IBC
  3. ASCE-7

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control panels.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings: For high-pressure carbon-dioxide fire-extinguishing system signed and sealed by a qualified professional engineer.
  1. Include plans, elevations, sections, and mounting/attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
  4. Design Calculations: For weight, volume, and concentration of extinguishing agent required for each hazard area.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For carbon-dioxide fire-extinguishing system to include in emergency, operation, and maintenance manuals.
- G. LEED Submittals: Submit in accordance with Section 01 81 11.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE):
1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- C. American Society of Mechanical Engineers (ASME): (Copyrighted Society):
1. B31.1-08 Power Piping
  2. B31.9-08 Building Services Piping
- D. American Society for Testing and Materials (ASTM):
1. A182/A182M-11a Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
  2. A269/A269M-10 Standard Specification for Seamless and Welded Stainless Steel Tubing for General Service
  3. A312/A312M-11 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- E. Code of Federal Regulations
1. 49 CFR 178-07 Specifications for Packagings

- F. Compressed Gas Association (CGA)
  - 1. CGA G-6.2-11 Commodity Specification for Carbon Dioxide
- G. Factory Mutual Engineering Corporation (FM)
  - 1. 2010 Approval Guide
- H. InterNational Electrical Testing Association (NETA)
  - 1. NETA Acceptance Testing Specification - 2009
- I. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
  - 1. SP-58-2009 Pipe Hangers and Supports-Materials, Design and Manufacture
- J. National Fire Protection Association (NFPA):
  - 1. 12-08 Standard on Carbon Dioxide Extinguishing Systems
  - 2. 72-07 National Fire Alarm Code
- K. Underwriters Laboratories, Inc (UL):
  - 1. 2011 Fire Protection Equipment Directory
  - 2. 268-06 Smoke Detectors for Fire Protective Signaling Systems - With Revisions Through January 1999

## **PART 2 - PRODUCTS**

### **2.1 SYSTEM DESCRIPTION**

- A. Total-Flooding System: Pre-engineered carbon-dioxide fire-extinguishing system designed for total flooding of the gas turbine generator enclosure.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Compliance: Fire-extinguishing system, equipment, and components shall comply with NFPA 12.
- D. FM Global Compliance: Provide components that are FM Approved and that are listed in FM's "Approval Guide."
- E. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer to design a carbon-dioxide fire-extinguishing system and obtain approval from

Contracting Officer and Resident Engineer. The performance shall meet the requirements of the gas turbine generator manufacturer.

1. Total-Flooding System Design Criteria:
  - a. Hazard Type: Power generation.
  - b. Discharge carbon dioxide for minimum 60 seconds and maintain minimum 50 percent concentration by volume at 70 deg F for minimum 10-minute holding time in hazard area, or as otherwise required by gas turbine generator manufacturer.
2. High-Pressure Piping Design Criteria:
  - a. Comply with ASME B31.1.
  - b. Internal Pressure: 2800 psig.

### **2.3 CARBON DIOXIDE**

- A. Vapor Phase: Equal to or more than 99.5 percent carbon dioxide.
- B. Taste and Odor: None detectable.
- C. Water Content: Comply with CGA G-6.2.
- D. Oil Content: Equal to or less than 10 ppm by weight.

### **2.4 PIPING MATERIALS**

- A. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 12, Section "Distribution," for charging pressure of system.

### **2.5 PIPES AND FITTINGS**

- A. Stainless-Steel Pipe: ASTM A 269/A 269M or ASTM A 312/A 312M, Grade TP316L, Schedule 80.
  1. Stainless-Steel Fittings: ASTM A 182/A 182M, Class 3000.

### **2.6 VALVES**

- A. Ball Valves: 316 Stainless Steel body and trim, graphite seals, fire safe, lockable handles. Provide with position switch.

### **2.7 FLEXIBLE-HOSE CONNECTORS**

- A. Description: Teflon-lined, braided hose with stainless-steel wire-braid covering.
  1. Burst Pressure: 5000 psi minimum.
  2. End Connections: Threaded male couplings.

### **2.8 CARBON-DIOXIDE CYLINDERS**

- A. Operating Pressure: Between 2400 psi and 3000 psi.
  1. Pressure Relief Device: Rupture-disk type.
    - a. Sized and fitted according to 49 CFR 178.



- B. Ambient Storage Conditions: Less than 120 deg F and more than 32 deg F.
- C. Storage Racks: Fabricate racks with restraints for upright cylinders. Provide weighing scale with rack.
- D. Storage Cylinder Nominal Size: 100 lb.

## **2.9 CYLINDER VALVES**

- A. Bursting Pressure Rating:
  - 1. Valves under Constant Pressure: 6000 psi.
  - 2. Valves Not under Constant Pressure: 5000 psi.
- B. Discharge Valves:
  - 1. Actuation: Electric.
  - 2. Solenoid Actuator: 24-V dc.
  - 3. Valve Material: Brass or stainless steel.
  - 4. Slave Valve Material: Brass.
  - 5. Lock-Out: Key-operation selector, for prevention of discharge during maintenance.
- C. Manifold: 304 Stainless Steel.
- D. Discharge Indicator: Pop-up indicator in manifold, 3/4 inch NPT, brass body.

## **2.10 DISCHARGE NOZZLES**

- A. Equipment manufacturer's standard material of working pressure, size, discharge pattern, and capacity required for application.
- B. Multijet, 1/2 inch NPT, cadmium plated.

## **2.11 HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod with compatible nuts and washers.
- B. Stainless-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod with compatible nuts and washers.

## **2.12 CONTROL PANELS**

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.

## **2.13 DETECTION DEVICES**

- A. General Requirements for Detection Devices:
  1. Comply with NFPA 12, NFPA 72, and UL 268.
  2. 24-V dc, nominal.
- B. Optical Flame Detectors: IR flame detector, ATEX certified, 90 degree view cone, Form C contacts, 24-V dc (Fault, Flame).
- C. Thermal Spot Detectors: Thermal switch, Form A, 24-V dc, 450 deg F (turbine end), 225 deg F (generator end), plus rate of rise, explosion proof.
- D. Combustible Gas Detector: Include air-sampling pipe network, catalytic gas sensor, transmitter, and control unit.

## **2.14 MANUAL STATIONS**

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel. Explosion proof.

## **2.15 SWITCHES**

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction. Explosion proof where noted or required.
- B. Valve Position Switch: NEMA 7, UL approved, 24-V dc/1000 ohms, aluminum housing with yellow and black beacon, polyurethane coating, Buna-N seals.

## **2.16 ALARM DEVICES**

- A. Description: FM Approved or listed and labeled by a nationally recognized testing agency acceptable to authorities having jurisdiction; low voltage and explosion proof.
- B. Horns: Indoor/Outdoor, 24-V dc, 100-110 db at 10 feet, whooping, explosion proof with tone card yelping. Include silence switch.
- C. Strobe Lights: Red strobe, 24-V dc, explosion proof.

## **2.17 NAMEPLATE WARNING SETS**

- A. Provide warning nameplates as scheduled on Drawings and additional nameplates as required by gas turbine generator manufacturer.

# **PART 3 - EXECUTION**

## **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## **3.2 INSTALLATION**

- A. Comply with requirements in NFPA 12.
- B. Install piping in accordance with locations presented by gas turbine generator manufacturer, and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating.
- D. Install piping to permit valve servicing.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and for branch connections.
- G. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 12, Section "Distribution Systems."
  - 1. Install pressure relief devices in piping systems.
  - 2. Install seismic restraints for carbon-dioxide cylinders and piping systems.

3. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 12, Section "Detection, Actuation, and Control," as required for supervised system application.

- H. Install carbon-dioxide cylinders in racks anchored to substrate.

### **3.3 HANGERS AND SUPPORTS**

- A. Field fabricate hangers and supports from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- C. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes to facilitate draining moisture and to not exceed maximum pipe deflections allowed by ASME B31.9 for building-services piping.
- G. Install carbon-steel hangers and supports for steel piping and stainless-steel hangers and supports for stainless-steel piping.
  1. Supports: MSS Type 1, adjustable, steel, clevis hangers, or other approved supports or brackets required by gas turbine generator manufacturer.
- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch-minimum rods.
- I. Install seismic restraints on piping.

### **3.4 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Connect electrical devices to control panel and to building's fire-alarm system.

- D. Comply with requirements in Section 260511 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES" for electrical power wiring.
- E. Piping Connections for NPS 1/4 to 1/2: Braided stainless-steel hose with threaded male couplings.

### **3.5 IDENTIFICATION**

- A. Identify system components and equipment per requirements of gas turbine generator manufacturer.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 11 "REQUIREMENTS FOR ELECTRICAL INSTALLATIONS."
- C. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 12.
- D. Install all warning signs.

### **3.6 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections according to NFPA 12 with the assistance of a factory-authorized service representative:
  - 1. Visual Inspections:
    - a. Inspect piping, equipment, and nozzles for proper size and location.
    - b. Verify that locations of alarms and manual emergency releases comply with approved Drawings.
    - c. Compare actual hazard configuration to original specification.
    - d. Inspect system for openings or other possible leakage paths.
    - e. Inspect labeling of devices and equipment for proper identification and nameplate data.
  - 2. Testing: After installing carbon-dioxide fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
    - a. Perform nondestructive operational tests on all equipment.
    - b. Perform full-discharge test on all hazards.
    - c. Perform each electrical test and visual and mechanical inspection stated in NETA's "Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems," Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
    - d. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    - e. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

- f. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Carbon-dioxide fire-extinguishing system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.7 SYSTEM FILLING**

- A. Preparation:
  - 1. Verify that piping system installation is complete and clean.
  - 2. Check system for complete enclosure integrity.
  - 3. Check operation of ventilation and exhaust systems.
- B. Filling Procedures:
  - 1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
  - 2. Install filled extinguishing-agent containers.
  - 3. Energize circuits.
- C. Adjust operating controls.

### **3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain carbon-dioxide fire-extinguishing system.

### **3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - -END - - -

**SECTION 22 05 11**

**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
  - 1. Exposed: Piping and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. HRSG: Heat Recovery Steam Generator. HRSG may also be referred to as "boiler." Unless applicable specifically to the existing boilers in Building 40, the term "boiler" used in conjunction with the cogeneration plant is referring to the HRSG.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 31 20 00, EARTH MOVING: Excavation and Backfill.
- G. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- H. Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- I. Section 05 50 00, METAL FABRICATIONS.
- J. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- K. Section 07 92 00, JOINT SEALANTS.
- L. Section 09 91 00, PAINTING.

- M. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- N. Section 22 07 11, PLUMBING INSULATION.
- O. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.
- P. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- Q. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- R. Section 26 29 11, MOTOR STARTERS.

### **1.3 QUALITY ASSURANCE**

#### **A. Products Criteria:**

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.
2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.



6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  8. Asbestos products or equipment or materials containing asbestos shall not be used.
- B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the American Welding Society.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.
  2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.
- E. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- F. Plumbing Systems: IPC, International Plumbing Code.

- G. Seismic Requirements: See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Earthquake-resistive design shall comply with the referenced editions of the following:
1. VA Handbook H-18-8, Seismic Design Requirements
  2. IBC
  3. ASCE-7
  4. Where individual Division 22 sections call for seismic certification or qualification of equipment in accordance with ASCE 7-05, the contractor shall not assume that the equipment types and styles called for in the drawings or specifications have been previously tested or approved in accordance with ASCE 7 requirements. If the exact equipment type or style is not available with a current certification, the contractor shall assume that shake testing will be required. If the contractor elects in lieu of shake testing to submit a similar product that does have certification or otherwise meets the requirements of the ASCE 7, the contractor assumes all costs associated with the similar product including but not limited to increased electrical and structural requirements, larger or increased amounts of piping and noise mitigation if approved by the resident engineer.

#### **1.4 SUBMITTALS**

- A. Submittals shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Upon request by Government, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.

- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
  2. Equipment and materials identification.
  3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  4. Wall, floor, and ceiling plates.
- H. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
1. Mechanical equipment rooms.
  2. Interstitial space.
  3. Hangers, inserts, supports, and bracing.
  4. Pipe sleeves.
  5. Equipment penetrations of floors, walls, ceilings, or roofs.
- I. Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
  3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- J. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as

appropriate.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

##### **A. Protection of Equipment:**

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the RE/COTR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

##### **B. Cleanliness of Piping and Equipment Systems:**

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

#### **1.6 APPLICABLE PUBLICATIONS**

##### **A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.**

##### **B. American Society of Civil Engineers (ASCE):**

1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.

##### **C. American Society of Mechanical Engineers (ASME):**

1. Boiler and Pressure Vessel Code (BPVC):
2. SEC IX-2007 Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications.

- D. American Society for Testing and Materials (ASTM):
  - 1. A36/A36M-2005 Standard Specification for Carbon Structural Steel
  - 2. A575-96 (R 2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
  - 3. E84-2004 Standard Test Method for Surface Burning Characteristics of Building Materials
  - 4. E119-2007a Standard Test Methods for Fire Tests of Building Construction and Materials
- E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - 1. SP-58-02 Pipe Hangers and Supports-Materials, Design and Manufacture
  - 2. SP 69-2003 (R 2004) Pipe Hangers and Supports-Selection and Application
- F. National Electrical Manufacturers Association (NEMA):
  - 1. MG1-2003, Rev. 1-2007 Motors and Generators
- G. International Code Council, (ICC):
  - 1. IBC-09, International Building Code
  - 2. IPC-09, International Plumbing Code

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.
  - 2. Constituent parts that are alike shall be products of a single manufacturer.
  - 3. Components shall be compatible with each other and with the total assembly for intended service.
  - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

- D. Major items of equipment, which serve the same function, shall be the same make and model

## **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

## **2.3 SAFETY GUARDS**

- A. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- B. All Equipment shall have moving parts protected from personal injury.

## **2.4 LIFTING ATTACHMENTS**

- A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.5 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.
- B. Special Requirements:
  - 1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
  - 2. Assemblies of motors, starters, and controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
  - 3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:

- a. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
4. Motor sizes shall be selected so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG1, Part 31.4.4.2.
- C. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency or Premium Efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as "high efficiency or premium efficient" shall comply with EPACT.
- D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.
- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

## **2.6 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the respective pump manufacturer, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps, shall be product of a single manufacturer.
- C. Motors shall be premium efficient type, "inverter duty", and be approved by the motor controller manufacturer. The controller-motor combination

shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.

- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

## **2.7 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, fans, etc. shall be identified.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
  - 2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage, 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
  - 4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling.



**2.8 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint.

**2.9 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC), latest edition, and SECTION 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Submittals based on the International Building Code (IBC), latest edition, SECTION 13 05 41 requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in the state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the Resident Engineer in all cases. See these specifications for lateral force design requirements.
- B. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
1. Concrete insert: Type 18, MSS SP-58.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition, and shall be tested and qualified for use in cracked concrete per ACI 355.2 and ICC-ES AC 193. Anchors to have a current ICC-ES report approved for cracked concrete (seismic) use under the 2009 IBC. Install anchors in accordance with the ICC-ES report and manufacturer's instructions
  3. Power-driven fasteners: Not permitted.
- D. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
  2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8-inch) outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 36 00, COMPOSITE METAL DECKING .
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held,

hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.

1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2-inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.

I. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.

1. General Types (MSS SP-58):
  - a. Standard clevis hanger: Type 1; provide locknut.
  - b. Riser clamps: Type 8.
  - c. Wall brackets: Types 31, 32 or 33.
  - d. Roller supports: Type 41, 43, 44 and 46.
  - e. Saddle support: Type 36, 37 or 38.
  - f. Turnbuckle: Types 13 or 15.
  - g. U-bolt clamp: Type 24.
  - h. Copper Tube:
    - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
    - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
    - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
    - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
  - i. Spring hangers are required on all plumbing system pumps one horsepower and greater.
2. Plumbing Piping (Other Than General Types):
  - a. Horizontal piping: Type 1, 5, 7, 9, and 10.
  - b. Chrome plated piping: Chrome plated supports.
  - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
  - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.

J. Pre-insulated Calcium Silicate Shields:

1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
3. Shield thickness shall match the pipe insulation.
4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
  - a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
  - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

K. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**2.10 PIPE PENETRATIONS**

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

- F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.
- G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be provided for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel Sleeve shall be provided for pipe passing through floor of mechanical rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.
- H. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.
- J. Flashing for wall and roof penetrations: Refer to Section 07 60 00.

#### **2.11 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: Metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

#### **2.12 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch) pipe, 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where

insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

### **2.13 ASBESTOS**

- A. Materials containing asbestos are not permitted.

### **2.14 VIBRATION ISOLATION**

- A. Vibration isolate all pipes in sound-rated construction except vents, gas, and sprinkler lines. Do not allow piping, plumbing, or vent stacks to contact gypsum board
- B. Do not suspend plumbing or piping from ducts, conduits, or related supports.
- C. Domestic water piping in sound-rated construction is to be isolated using felt or neoprene-lined resilient attachments as appropriate.

## **PART 3 - EXECUTION**

### **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
  - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type

- drill will not be allowed, except as permitted by RE/COTR where working area space is limited.
2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
  3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- G. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- J. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. shall be used for all pad or floor mounted equipment. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- L. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and section 23 09 23 FACILITY MONITORING AND CONTROL SYSTEM.

M. Work in Existing Building:

1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.

N. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.

O. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

P. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

### **3.2 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 shall apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

### **3.3 RIGGING**

- A. Openings in building structures shall be planned to accommodate design scheme.

- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.

#### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Resident Engineer.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC), referenced edition, and these specifications.
- E. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.



F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.
4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**3.5 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to RE/COTR in unopened containers that are properly identified as to application.
- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

**3.6 PLUMBING SYSTEMS DEMOLITION**

- A. Rigging access, other than indicated on the drawings, shall be provided after approval for structural integrity by the RE/COTR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, approved protection from dust and debris shall be provided at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area

concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards. Inspections will be made by personnel of the VA Medical Center, and the Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.

- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to RE/COTR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

### **3.7 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
  - 2. The following Material And Equipment shall NOT be painted::
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.

- h. Valve stems and rotating shafts.
  - i. Pressure gages and thermometers.
  - j. Glass.
  - k. Name plates.
- 3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.
- 4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
- 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
- 6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

### **3.8 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.9 IDENTIFICATION SIGNS**

- A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor

responsibilities for system commissioning.

### **3.11 STARTUP AND TEMPORARY OPERATION**

- A. Start up of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.12 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

### **3.13 OPERATION AND MAINTENANCE MANUALS**

- A. Provide four bound copies. The Operations and maintenance manuals shall be delivered to RE/COTR not less than 30 days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.
- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- G. Set points of all interlock devices shall be listed.
- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.

I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.

J. Emergency procedures.

**3.14 INSTRUCTIONS TO VA PERSONNEL**

A. Instructions shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

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**SECTION 22 05 12**

**GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section describes the general motor requirements for plumbing equipment.

**1.2 RELATED WORK:**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one section of Division 26.
- E. Section 26 29 11, MOTOR STARTERS: Starters, control and protection of motors.
- F. Section 26 24 19, MOTOR-CONTROL CENTERS: Motor Control Centers.

**1.3 SUBMITTALS**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Motor nameplate information shall be submitted including electrical ratings, dimensions, mounting details, materials, horsepower, power factor, current as a function of speed, current efficiency, speed as a function of load, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
  - 3. Motor parameters required for the determination of the Reed Critical Frequency of vertical hollow shaft motors shall be submitted.

C. Manuals:

1. Companion copies of complete maintenance and operating manuals, including technical data sheets and application data shall be submitted simultaneously with the shop drawings.

D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:

1. Certification shall be submitted stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.

E. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 APPLICABLE PUBLICATIONS:**

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) shall form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
  1. MG 1-07 Motors and Generators
  2. MG 2-01 Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators
- C. National Fire Protection Association (NFPA):
  1. 70-08 National Electrical Code (NEC)

**PART 2 - PRODUCTS**

**2.1 MOTORS:**

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. Voltage ratings shall be as follows:
  1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.



2. Three phase:
  - a. Motors connected to 208-volt systems: 200 volts.
  - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
  - c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
  - d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
  - e. Motors connected to high voltage systems: Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- C. Number of phases shall be as follows:
  1. Motors, less than 373 W (1/2 HP): Single phase.
  2. Motors, 373 W (1/2 HP) and larger: 3 phase.
  3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- F. Motor Enclosures:
  1. Shall be the NEMA types shown on the drawings for the motors.
  2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.
  3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
  4. All motors in hazardous locations shall be approved for the application and meet the Class and Group as required by the area classification.
- G. Electrical Design Requirements
  1. Motors shall be continuous duty.
  2. The insulation system shall be rated minimum of class B, 130° C (266° F).
  3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80° C (176° F).

4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
5. Motors shall be suitable for full voltage starting, unless otherwise noted.
6. Motors for variable frequency drive applications shall adhere to NEMA standards publication MG 1, Part 30, Application considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable voltage or Adjustable frequency controls, or both, or Part 31, Definite Purpose Inverter Fed Polyphase Motors.

H. Mechanical Design Requirements

1. Bearings shall be rated for a minimum of 26,280 hours L-10 life at full load direct coupled, except vertical high thrust motors.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30% of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 0.15 inch per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5° C (41° F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

I. Additional requirements for specific motors, as indicated in other sections, shall also apply.

J. NEMA Premium Efficiency Electric Motors, Motor Efficiencies All permanently wired polyphase motors of 746 Watts (1 Horsepower) or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 Watts (one horsepower) or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Efficiencies Open Drip-Proof				Minimum Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- K. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM. Power factor correction capacitors shall be installed unless the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION:**

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

#### **3.2 FIELD TESTS**

- A. Megger all motors after installation, before start-up. All shall test free from grounds.

#### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 22 05 19**

**METERS AND GAGES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for pressure gages. For water meters, refer to Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM (FMCS).

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM (FMCS).

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pressure Gages.
  - 2. Product certificates for each type of meter and gauge.
- C. Operations and Maintenance manual shall include:
  - 1. System Description
  - 2. Major assembly block diagrams
  - 3. Troubleshooting and preventive maintenance guidelines
  - 4. Spare parts information.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form

provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
- C. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - 1. B40.1-05 Gauges-Pressure Indicating Dial Type-Elastic
- D. International Code Council (ICC):
  - 1. IPC-09 International Plumbing Code

#### **1.5 AS-BUILT DOCUMENTATION**

- A. The electronic documentation and copies of the Operations and Maintenance Manual, approved submittals, shop drawings, and other closeout documentation shall be prepared by a computer software program complying with Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C 794d). The manufacturer or vendor of the software used to prepare the electronic documentation shall have a Voluntary Product Accessibility Template made available for review and included as part of the Operations and Maintenance Manual or closeout documentation. All available accessibility functions listed in the Voluntary Accessibility Template shall be enabled in the prepared electronic files. As Adobe Acrobat is a common industry format for such documentation, following the document, "Creating Accessible Adobe PDF files, A Guide for Document Authors" that is maintained and made available by Adobe free of charge is recommended."
- B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- C. Four sets of operation and maintenance data updated to include submittal review comments shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

## **PART 2 - PRODUCTS**

### **2.1 PRESSURE GAGES FOR WATER AND SEWAGE USAGE**

- A. ANSI B40.1 all metal case 114 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 1375 kPa (0 to 200 psi) gauge.
- B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.
- C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psi.
- D. The pointer shall be dark colored metal.
- E. The window shall be glass.
- F. The ring shall be brass or stainless steel.
- G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Direct mounted pressure gages shall be installed in piping tees with pressure gage located on pipe at the most readable position.
- B. Valves and snubbers shall be installed in piping for each pressure gage.
- C. Test plugs shall be installed on the inlet and outlet pipes all heat exchangers or water heaters serving more than one plumbing fixture.
- D. Pressure gages shall be installed where indicated on the drawings and at the following locations:
  - 1. Building water service entrance into building
  - 2. Inlet and outlet of each pressure reducing valve
  - 3. Suction and discharge of each domestic water pump or re-circulating hot water return pump.

### **3.2 FIELD QUALITY CONTROL**

- A. The meter assembly shall be visually inspected and operationally tested. The correct multiplier placement on the face of the meter shall be verified.

### **3.3 TRAINING**

- A. A training course shall be provided to the medical center on meter configuration and maintenance. Training manuals shall be supplied for all

attendee with four additional copies supplied. The training course shall cover meter configuration, troubleshooting, and diagnostic procedures.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 22 05 23**

**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Valves.
  - 2. Backflow Preventers.
  - 3. All items listed in Part 2 - Products.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

1. A276-10 Standard Specification for Stainless Steel Bars and Shapes
2. A536-84(R 2004) E1 Standard Specification for Ductile Iron Castings
3. B584-11 Standard Specification for Copper Alloy Sand Castings for General Applications
4. B62-09 Standard Specification for Composition Bronze or Ounce Metal Castings

C. American Society of Sanitary Engineering (ASSE)

1. ASSE 1001-08 Performance Requirements for Atmospheric Type Vacuum Breakers
2. ASSE 1013-05 Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers

D. International Code Council (ICC)

1. IPC-09 International Plumbing Code

E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

1. SP-25-98 Standard Marking System for Valves, Fittings, Flanges and Unions  
SP-67-02a (R 2004) Butterfly Valve of the Single flange Type (Lug Wafer)
2. Sp-67-04 Butterfly Valves
3. SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose
4. SP-80-03 Bronze Gate, Globe, Angle and Check Valves.
5. SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

**1.5 DELIVERY, STORAGE, AND HANDLING**

A. Valves shall be prepared for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Valves shall be prepared for storage as follows:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

## **PART 2 - PRODUCTS**

### **2.1 VALVES**

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.
- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 meters (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- E. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.
- F. Shut-off:
  1. Cold, Hot and Re-circulating Hot Water:
    - a. 50 mm or DN50 (2 inches) and smaller:
      - 1) Ball, MSS SP-72, SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be solder type.
    - b. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A 536, ductile iron.
- G. Balancing:

1. Hot Water Re-circulating, 80 mm or DN80 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (1/4" NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.

H. Check:

1. Check valves less than 80 mm or DN80 (3 inches) and smaller) shall be class 125, bronze swing check valves with non metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.
  - a. All check valves on the discharge side of submersible sump sumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

I. Globe:

1. 80 mm or DN80 (3 inches) or smaller: Class 150, bronze globe valve with non metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B 62 with solder ends, copper-silicon bronze stem, TPFE or TFE disc, malleable iron hand wheel.

## 2.2 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be ASSE 1013 listed and certified.
- B. Reduced Pressure Backflow Preventer shall be installed in the following applications.
  1. Water make-up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.
- C. Atmospheric Vacuum Breaker: ASSE 1001
  1. Hose bibs and sinks w/threaded outlets.
- D. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated duct iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be

Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A276. The seat disc elastomer shall be EPDM. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet.

- E. The atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be either cast bronze. All internal polymers shall be NSF listed. The seat disc elastomer shall be silicone. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable.

## **2.3 CHAINWHEELS**

- A. Valve chain wheel assembly with sprocket rim brackets and chain shall be constructed according to the following:
  - 1. Brackets: type, number, size, and fasteners required to mount actuator on valve.
  - 2. Attachment: For connection to ball or butterfly valve stem.
  - 3. Sprocket rim with chain guides: Aluminum or bronze of type and size required for valve with zinc coating.
  - 4. Chain: hot dipped galvanized steel of size required to fit sprocket rim.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.2 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Install chain wheels on operators for ball, butterfly, gate and globe valves NPS 65 mm or DN65 (2-1/2 inches) and larger and more than [2400 mm (12 feet) above floor. Chains shall be extended to 1500 mm 3600 mm (60 inches) above finished floor.
- F. Check valves shall be installed for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.

### **3.3 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves shall be replaced if persistent leaking occurs.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

**SECTION 22 07 11**

**PLUMBING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. Plumbing piping and equipment.
  - 2. Re-insulation of plumbing piping and equipment after asbestos abatement.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. Cold: Equipment or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  - 4. Concealed: Piping above ceilings and in chases, interstitial space, and pipe spaces.
  - 5. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-scrim-kraft facing.
  - 7. Hot: Plumbing equipment or piping handling media above 41 degrees C (105 degrees F).
  - 8. Density:  $\text{kg/m}^3$  - kilograms per cubic meter (Pcf - pounds per cubic foot).
  - 9. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: Watts per square meter (BTU per hour per square foot).
    - b. Pipe or Cylinder: Watts per square meter (BTU per hour per linear foot).
  - 10. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
  - 11. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.

- 12. R: Pump recirculation.
- 13. CW: Cold water.
- 14. SW: Soft water.
- 15. HW: Hot water.
- 16. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General mechanical requirements and items, which are common to more than one section of Division 22.
- E. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING and Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.

## **1.3 QUALITY ASSURANCE**

- A. Refer to article QUALITY ASSURANCE, in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- B. Criteria:
  - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:
    - 4.3.3.1 Pipe insulation and coverings, vapor retarder facings, adhesives, fasteners, tapes, unless otherwise provided for in 4.3.3.1.12 or 4.3.3.1.2, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
    - 4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)
    - 4.3.3.3 Pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.
    - 4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).



4.3.10.2.6.3 Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

4.3.10.2.6.7 Smoke detectors shall not be required to meet the provisions of this section.

2. Test methods: ASTM E84, UL 723, or NFPA 255.
  3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
  4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
    - a. Insulation materials: Specify each type used and state surface burning characteristics.
    - b. Insulation facings and jackets: Each type used.
    - c. Insulation accessory materials: Each type used.
    - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
    - e. Make reference to applicable specification paragraph numbers for coordination.
- C. Samples:
1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
  2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
  3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

D. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 STORAGE AND HANDLING OF MATERIAL**

- A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
1. L-P-535E (2)-91 Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
1. MIL-A-3316C (2)-90 Adhesives, Fire-Resistant, Thermal Insulation
  2. MIL-A-24179A (1)-87 Adhesive, Flexible Unicellular-Plastic
  3. Thermal Insulation
  4. MIL-C-19565C (1)-88 Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
  5. MIL-C-20079H-87 Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- D. American Society for Testing and Materials (ASTM):
1. B209-06 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  2. C-177-10 Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
  3. C411-05 Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
  4. C449-07 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
  5. C518-10 Standard Test Method for Steady State Thermal

Transmission Properties by Means of the Heat Flow Meter Apparatus

6. C534-08 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
  7. C547-06 Standard Specification for Mineral Fiber pipe Insulation
  8. C1136-10 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
  9. D1668-97a (2006) Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
  10. E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials
  11. E119-07a Standard Test Method for Fire Tests of Building Construction and Materials
  12. E136-04 Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)
- E. National Fire Protection Association (NFPA):
1. 101-09 Life Safety Code
  2. 251-06 Standard methods of Tests of Fire Endurance of Building Construction Materials
  3. 255-06 Standard Method of tests of Surface Burning Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
1. 723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with 2005 Revision
- G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
1. SP58-2002 Pipe Hangers and Supports Materials, Design, and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.037$  (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

### **2.2 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C177, C518,  $k = 0.039$  (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

### 2.3 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance  $\leq 0.02$  or less perm rating, Beach puncture 50 units for insulation facing on pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- E. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- F. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

### 2.4 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass insulation of the same thickness as adjacent insulation.

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density cellular glass. Insulation at supports shall have same thickness as adjacent insulation.

## **2.5 ADHESIVE, MASTIC, CEMENT**

- A. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. Other: Insulation manufacturers' published recommendations.

## **2.6 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized steel
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 13 mm (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

## **2.7 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.

- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **2.8 FLAME AND SMOKE**

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as cold water pumps and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum

- covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. Plumbing work not to be insulated:
1. Piping and valves of fire protection system.
  2. Chromium plated brass piping.
  3. Water piping in contact with earth.
  4. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).
  5. Distilled water piping.
- I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- J. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- K. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (0.75) thick insulation, for all pipe sizes 75 mm (3 inches) and smaller and 25 mm (1 inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up where indicated on the drawings as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- L. Provide vapor barrier jackets over insulation as follows:
1. All piping exposed to outdoor weather.
- M. Provide metal jackets over insulation as follows:
1. All plumbing piping exposed to outdoor weather.
  2. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### **3.2 INSULATION INSTALLATION**

- A. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may

be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.

2. Contractor's options for fitting, flange and valve insulation:
  - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
  - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
  - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
  - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

B. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
  - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.—



**3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.4 PIPE INSULATION SCHEDULE**

- A. Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----

**3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 22 11 00**

**FACILITY WATER DISTRIBUTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. SECTION 22 07 11, PLUMBING INSULATION

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. All items listed in Part 2 - Products.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
- C. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  - 1. A13.1-1996 (R2002) Scheme for Identification of Piping Systems
  - 2. B16.18-01 (R2005) Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME
  - 3. B16.22-01 (R2005) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME Element ANSI/ASME
  - 4. NSF/ANSI 61 Drinking Water System Components - Health Effects
- D. American Society for Testing and Materials (ASTM):
  - 1. A47/A47M-99(2009) Ferritic Malleable Iron Castings Revision 1989
  - 2. A183-03(2009) Carbon Steel Track Bolts and Nuts
  - 3. A536-84(2009) Ductile Iron Castings
  - 4. B32-08 Solder Metal
  - 5. B75-02 Seamless Copper Tube
  - 6. B88-03 Seamless Copper Water Tube
  - 7. B300-10 AWWA Standard for Hypochlorites
  - 8. B301-10 AWWA Standard for Liquid Chlorine
  - 9. B584-09a Copper Alloy Sand Castings for General Applications Revision A
  - 10. E1120-08 Standard Specification For Liquid Chlorine
  - 11. E1229-08 Standard Specification For Calcium Hypochlorite
- E. American Water Works Association (AWWA):
  - 1. C151/A21.51-09 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids AWWA/ ANSI
  - 2. C651-05 Disinfecting Water Mains
- F. American Welding Society (AWS):
  - 1. A5.8M:2004 Filler Metals for Brazing
- G. International Plumbing Code
  - 1. International Plumbing Code - 2009
- H. American Society of Sanitary Engineers (ASSE):
  - 1. ANSI/ASSE (Plumbing)
  - 2. ANSI/ASSE 1010-2004 Water Hammer Arresters

- I. Plumbing and Drainage Institute (PDI):
  - 1. PDI WH-201 2007 Water Hammer Arrestor

#### **1.5 QUALITY ASSURANCE**

- A. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and more than one year old.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- C. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

### **PART 2 - PRODUCTS**

#### **2.1 UNDERGROUND DOMESTIC AND INDUSTRIAL COLD WATER (NON-POTABLE WATER) SERVICE CONNECTIONS TO BUILDINGS**

- A. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material selected shall be the same for the size specified.
- B. Seventy five millimeters (3 inch) Diameter and Over: Ductile iron, AWWA C151, 850 kPa (125 psi) water steam pressure (WSP), exterior bituminous coating, and cement lined. Provide flanged and anchored connection to interior piping.
- C. Under 75 mm (3 inch) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings as specified under Article 2.2, INTERIOR DOMESTIC WATER PIPING. Use brazing alloys, AWS A5.8, Classification BCuP.

#### **2.2 ABOVE GROUND (INTERIOR) DOMESTIC WATER PIPING AND (INTERIOR AND EXTERIOR) INDUSTRIAL COLD WATER (NON-POTABLE WATER) PIPING**

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn.
- B. Fittings for Copper Tube:
  - 1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
  - 2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
  - 3. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing

out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.

- C. Adapters: Provide adapters for joining screwed pipe to copper tubing.
- D. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.
- E. Brazing alloy: AWS A5.8, Classification BCuP.

### **2.3 EXPOSED WATER PIPING**

- A. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

### **2.4 TRAP PRIMER WATER PIPING:**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.
- C. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

### **2.5 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi-steel.

### **2.6 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

### **2.7 STERILIZATION CHEMICALS**

- A. Hypochlorites ANSI/AWWA B300-10
- B. Liquid Chlorine ANSI/AWWA B301-10

### **2.8 WATER HAMMER ARRESTER:**

- A. Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure

packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements (PDI WH 201). Provide water hammer arrestors at:

1. All solenoid valves.
2. All groups of two or more flush valves.
3. All quick opening or closing valves.
4. All medical washing equipment.

## **2.9 PIPE PROTECTION**

- A. Below grade copper domestic water and trap primer piping: Polyethylene tubing encasement conforming to ASTM D1248, 6 mils thick, colored blue for domestic water piping and clear for trap primer piping.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with the International Plumbing Code and the following:
  1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
  2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.
  3. All pipe runs shall be laid out to avoid interference with other work.
  4. Install union and shut-off valve on pressure piping at connections to equipment.
  5. Pipe Hangers, Supports and Accessories:
    - a. All piping shall be supported per the International Plumbing Code, Chapter No. 3.
    - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
    - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
      - 1) Solid or split unplated cast iron.
      - 2) All plates shall be provided with set screws.
      - 3) Pipe Hangers: Height adjustable clevis type.
      - 4) Adjustable Floor Rests and Base Flanges: Steel.
      - 5) Concrete Inserts: "Universal" or continuous slotted type.

- 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  - 7) Riser Clamps: Malleable iron or steel.
  - 8) Rollers: Cast iron.
  - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
  - 10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
  - 11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
  - 12) With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide calculations supporting the restraint length design and type of selected restraints.
6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  7. Penetrations:
    - a. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- B. Piping shall conform to the following:
1. Domestic Water:
    - a. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
    - b. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

### 3.2 TESTS

- A. General: Test system either in its entirety or in sections.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.



- C. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

### **3.3 STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use liquid chlorine or hypochlorites for sterilization.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 22 11 23**

**DOMESTIC WATER PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hot water recirculation pump.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- F. Section 26 29 11, MOTOR STARTERS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pump:
    - a. Manufacturer and model.
    - b. Operating speed.
    - c. Capacity.
    - d. Characteristic performance curves.
  - 2. Motor:
    - a. Manufacturer.
    - b. Speed.
    - c. Current Characteristics.
    - d. Efficiency.
- C. Certified copies of all the factory and construction site test data sheets and reports.

- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Underwriters' Laboratories, Inc. (UL):
  - 1. 508-99 (R2008) Standards for Safety Industrial Control Equipment

### **PART 2 - PRODUCTS**

#### **2.1 INLINE HOT WATER RECIRCULATING PUMP**

- A. Centrifugal in-line horizontal oil lubricated pump designed for quiet operation and 862 kPa (125 psi).
- B. Pump controlled from on/off aquastat located at pump. In addition, the pump shall be provided with an interface with the FMCS for scheduled time control. In the inlet and outlet piping of the pump shutoff valves shall be installed to permit service to the pump without draining the system. A check valve shall be installed in the pump discharge piping immediately downstream of the pump.

### **PART 3 - EXECUTION**

#### **3.1 STARTUP AND TESTING**

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. System Test: After installation is completed provide an operational test of the completed system including flow rates, pressure compliance, alarms and all control functions.
- C. When any defects are detected, correct defects and repeat test.
- D. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

#### **3.2 COMMISSIONING**

- A. Provide Commissioning Documentation accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this Section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

#### **3.3 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

#### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 22 13 00**

**FACILITY SANITARY AND VENT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- F. Section 22 07 11, PLUMBING INSULATION: Pipe Insulation.
- G. Section 22 11 00, FACILITY WATER DISTRIBUTION: Trap primer piping materials.
- H. Section 07 92 00 Joint Sealants: Sealant products.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Floor Drains.
  - 3. Cleanouts.
  - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
1. A112.6.3-01 (R 2007) Standard for Floor and Trench Drains
  2. A112.36.2M-91 (R2002) Cleanouts
  3. A13.1-96 (R2002) Scheme for Identification of Piping Systems
  4. B1.20.1-83 Pipe Threads, General Purpose, Inch
  5. B16.15-06 Cast Bronze Threaded Fittings
  6. B16.18-12 Cast Copper Alloy Solder Joint Pressure Fittings
  7. B16.22-01 (R 2005) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
  8. B16.23-07 Cast Copper Alloy Solder Joint Fittings - DWV
  9. B16.29-07 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
- C. American Society for Testing and Materials (ASTM):
1. A53/A53M-07 Standard Specification for Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless
  2. A74-06 Standard Specification for Cast Iron Soil Pipe and Fittings
  3. A888-11 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Applications
  4. B32-08 Standard Specification for Solder Metal
  5. B88-03 Standard Specification for Seamless Copper Water Tube
  6. B306-02 Standard Specification for Copper Drainage Tube (DWV)
  7. B687-99 (2011) Standard Specification for Brass, Copper, and Chromium Plated Pipe Nipples
  8. B813-10 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.



9. B828-02 (2010) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
  10. C564-03a Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
  11. D5926-11 Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV) Sewer, Sanitary, And Storm Plumbing Systems
  12. F1545-97(2009) Standard Specification for Plastic Lined Ferrous Metal Pipe, Fittings, and Flanges
- D. International Code Council:
1. IPC-09 International Plumbing Code
- E. Cast Iron Soil Pipe Institute (CISPI):
1. 301-05 Hubless Cast Iron Soil and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
  2. 310-04 Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- F. American Society of Sanitary Engineers (ASSE):
1. 1044-01 Trap Seal Primer Devices - Drainage Types and Electronic Design Types
  2. 1079-05 Dielectric Pipe Unions
- G. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
1. SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose
  2. SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends
- H. Plumbing and Drainage Institute (PDI):
1. PDI WH-201 Water Hammer Arrestor

## **PART 2 - PRODUCTS**

### **2.1 SANITARY WASTE, DRAIN, AND VENT PIPING**

- A. Cast iron waste, drain, and vent pipe and fittings
1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth
    - b. Sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
    - c. Interior waste and vent piping above grade.

2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.
4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with lead and oakum.

B. Copper Tube, (DWV):

1. Copper DWV sanitary waste, drain and vent tube may be used for vent piping 2-1/2 inches and smaller, and for drain piping above ground from lavatories, sinks and drinking fountains. DWV tube shall not be used for urinal drains.
2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

## **2.2 EXPOSED WASTE PIPING**

- A. Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
  2. The Fittings shall conform to ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
  3. Nipples shall conform to ASTM B 687, Chromium-plated.
  4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. In unfinished Rooms such as mechanical Rooms and Kitchens Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

## **2.3 PUMPED DRAIN PIPING**

- A. Pumped drain piping under 100 mm (4 inches) shall be copper tube conforming to ASTM B88, type K or L. For pumped drain piping 100 mm (4 inches) and above, galvanized steel conforming to A 53, seamless, schedule 40 may be used.

- B. Pumped drain pipe fittings shall comply with the following:
  - 1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22.
  - 2. Unions shall be bronze, Mss SP-72, SP-110. Solder or braze joints.
- C. The solder shall use a non-corrosive flux conforming to ASTM B32.

#### **2.4 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
  - 1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  - 2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

#### **2.5 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts

shall consist of wye fittings and eighth inch) bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on drawings and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.

- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

## **2.6 FLOOR DRAINS**

- A. Type B (FD-B) floor drain shall comply with ANSI A112.6.3. The type B floor drain shall be constructed of galvanized cast iron with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom. The grate shall be 175 mm (7 inches) minimum square grate.
- B. Type E (FD-E) floor drain shall comply with ANSI A112.6.3. The type E floor drain shall have a heavy, cast iron body, double drainage pattern, heavy non-tilting nickel bronze grate not less than 300 mm (12 inches) square, removable sediment bucket. Clearance between body and bucket shall be ample for free flow of waste water. For traffic use, an extra heavy duty load classification ductile iron grate shall be provided.
- C. Type O (FD-O) floor drain shall comply with ANSI A112.6.3. The type O floor drain shall have a cast iron body, double drainage pattern, clamping device, less grate and sediment basket but with dome type secondary strainer. The drain shall be 300 mm (12 inches) in diameter or 300 mm (12 inches) square and approximately 150 mm (6 inches) deep. The interior and exposed exterior surfaces shall have an acid resisting, enamel finish.

## **2.7 TRAPS**

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as pipe connected to. Slip joints not permitted on sewer side of trap. Traps shall correspond

to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

## **2.8 TRAP SEAL PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS**

- A. Trap Primer (TP-1): The trap seal primer system shall be electronic type conforming to ASSE 1044.
  - 1. The controller shall have a 24 hour programmable timer, solid state, 6 outlet zone, minimum adjustable run time of 1 minute for each zone, 12 hour program battery backup, manual switch for 120VAC power, 120VAC to 24VAC internal transformer, fuse protected circuitry, UL listed, 120VAC input-24VAC output, constructed of enameled steel or plastic.
  - 2. The cabinet shall be recessed mounting with a stainless steel cover.
  - 3. The solenoid valve shall have a brass body, Buna "N" seats, normally closed, 5.98 kPa (125 psi) rated, 24VAC.
  - 4. The control wiring shall be copper in accordance with the latest edition of the National Electric Code, Article 725 and not less than 18 gauge. All wiring shall be in conduit and in accordance with Division 26 of the specifications.
  - 5. The vacuum breaker shall conform to ASSE 1001.

## **2.9 WATERPROOFING**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

# **PART 3 - EXECUTION**

## **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed to permit valve servicing or operation.

- F. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- L. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".

### 3.2 **JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- C. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
  - 2. Pipe sections with damaged threads shall be replaced with new sections of pipe.

- D. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

### **3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES**

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).
- E. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
  - 1. Solid or split unplated cast iron.
  - 2. All plates shall be provided with set screws.
  - 3. Height adjustable clevis type.
  - 4. Adjustable Floor Rests and Base Flanges: Steel.
  - 5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  - 6. Riser Clamps shall be malleable iron or steel.
  - 7. Rollers shall be cast iron.
  - 8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- F. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories.

- G. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- H. Piping shall conform to the following:
1. Waste and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm or DN 80 (3 inches) and smaller	2%
100 mm or DN 100 (4 inches) and larger	1%

2. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

### 3.5 TESTS

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
  3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
  4. Final Tests: Either one of the following tests may be used.
    - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (2 ounces) of peppermint into each line or stack.



### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.7 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 22 13 29**

**SANITARY SEWERAGE PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Sanitary centrifugal sewerage pumps capable of handling 50 mm (2") solids.
- B. Pump capacity. See schedule on Drawing.
- C. Low voltage starters

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS. Requirements for commissioning, systems readiness checklist, and training.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- F. Section 26 29 11, MOTOR STARTERS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pump:
    - a. Manufacturer and model.
    - b. Operating speed.
    - c. Capacity.
    - d. Characteristic performance curves.
  - 2. Motor:
    - a. Manufacturer, .
    - b. Speed.
    - c. Current Characteristics and W (HP).
    - d. Efficiency.

- C. Certified copies of all the factory and construction site test data sheets and reports.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - 1. ICS6-1993 (R2006) Industrial Control and Systems Enclosures
  - 2. 250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. Underwriters' Laboratories, Inc. (UL):
  - 1. 508-99 (R2008) Standards For Safety Industrial Control Equipment

### **PART 2 - PRODUCTS**

#### **2.1 SANITARY SEWERAGE PUMP**

- A. Simplex pumps Centrifugal type designed for 60 degrees C (140 degrees F) maximum water service. Driver shall be electric motor. Support shall be rigid type. Systems to include two or more pumps as required by the Contract Documents. Where hazardous environment condition exists, explosion proof pumps shall be installed.
  - 1. Pump housings may be cast iron, bronze, or stainless steel. Cast iron housings for submersible pumps shall be epoxy coated.

- B. Impeller: Brass, bronze or cast iron, non-clog, to accommodate 50 mm (2") solids.
- C. Shaft: Stainless steel or other approved corrosion-resisting metal.
- D. Bearings: As required to hold shaft alignment, anti-friction type for thrust.
- E. Characteristics: Head capacity characteristics shall not permit overloading at any point of the pump curve.
- F. Motor: Completely enclosed, voltage and phase as shown in schedule on Electrical drawings conforming to NEMA 250-Type 6P. Size the motor capacity to operate pump without overloading the motor at any point on the pump curve. Refer to Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- G. Starting Switch: Manually-operated, tumbler type, as specified in Section 26 29 11, MOTOR STARTERS.
- H. Automatic Control and Level Alarm: Provide control panel in a NEMA 7 enclosure for hazardous environment areas. The controls shall be suitable for operation with the electrical characteristics listed on the Electrical drawings. The control panel shall have a level control system with switches to start and stop pumps automatically, and to activate a high water alarm. The level control system will include sensors in the sump that detect the level of the liquid. The sensors may be float type switches, ultrasonic level sensors, transducers, or other appropriate equipment. The high water alarm shall have a red beacon light at the control panel and a buzzer, horn, or bell. The alarm shall have a silencing switch. The circuitry of the control panel shall include:
  - 1. Power switch to turn on/off the automatic control mechanism
  - 2. HOA switches to manually override automatic control mechanism
  - 3. Run lights to indicate when pumps are powered up
  - 4. Level status lights to indicate when water in sump has reached the predetermined on/off and alarm levels
  - 5. Magnetic motor contactors
  - 6. Disconnect/breaker for each pump
  - 7. Automatic motor overload protection
  - 8. Provide auxiliary contacts for remote alarming to the Energy Control Center and BAC net compatible open-protocol type interface to DDC Controls System.
- I. Sensors that detect the level of water in the sump shall be so arranged as to allow the accumulation of enough volume of liquid below the normal on level that the pump will run for a minimum cycle time, as recommend by the pump manufacturer. Sensors shall be located to activate the alarm adequately before the water level rises to the inlet pipe.
- J. Provide a union, check and ball valve in the discharge from each pump.

### **PART 3 - EXECUTION**

#### **3.1 STARTUP AND TESTING**

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. The tests shall include system capacity and all control and alarm functions.
- C. When any defects are detected, correct defects and repeat test.
- D. The commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

#### **3.2 COMMISSIONING**

- A. Provide commissioning documentation accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

#### **3.3 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

#### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 22 14 00**

**FACILITY STORM DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training
- D. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- F. Section 22 07 11, PLUMBING INSULATION: Pipe Insulation.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Roof Drains.
  - 3. Cleanouts.
  - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance

with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI).
- C. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
  1. A112.21.2m-83 Roof Drains
  2. A112.36.2M-91 Cleanouts
  3. A13.1-96 (R2002) Scheme for Identification of Piping Systems
  4. B1.20.1-83 Pipe Threads, General Purpose (Inch)
- D. American Society for Testing and Materials (ASTM):
  1. A74-06 Standard Specification for Cast Iron Soil Pipe and Fittings
  2. A888-11 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Applications.
  3. C564-06a Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
- E. International Code Council (ICC):
  1. IPC-09 International Plumbing Code
- F. Cast Iron Soil Pipe Institute (CISPI):
  1. 301-05 Hubless Cast Iron Soil and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
  2. 310-04 Couplings for Use in Connection with Hubless Cast Iron Soil and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

## **PART 2 - PRODUCTS**

### **2.1 STORM WATER DRAIN PIPING**

- A. Cast Iron Storm Pipe and Fittings:
  1. Cast iron storm pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth.



- b. Extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls.
  - c. Interior storm piping above grade.
  - d. All mechanical equipment rooms or other areas containing mechanical air handling equipment.
- 2. The cast iron storm Pipe shall be bell and spigot, or hubless (plain end or no-hub) as required by selected jointing method.
- 3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.
- 4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with lead and oakum.

## **2.2 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts where shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

## **2.3 ROOF DRAINS AND CONNECTIONS**

- A. Roof Drains: Roof Drains (RD) shall be cast iron with clamping device for making watertight connection. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, a soft copper membrane shall be provided 300 mm (12 inches) in diameter greater than outside diameter of drain collar. An integral gravel stop shall be provided for drains installed on roofs having built up roofing covered with gravel or slag. Integral no-hub, soil pipe gasket or threaded outlet connection shall be provided.
1. Flat Roofs: The roof drain shall have a beehive or dome shaped strainer with integral flange not less than 300 mm (12 inches) in diameter. For an insulated roof, a roof drain with an adjustable drainage collar shall be provided, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. The Bottom section shall serve as roof drain during construction before insulation is installed.
  2. Roof Drains, Overflow: Roof Drains identified as overflow drains shall have a 50 mm (2 inch) water dam integral to the drain body.
- B. Expansion Joints: Expansions joints shall be heavy cast iron with cast brass or copper expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.
- C. Interior Downspouts: An expansion joint shall be provided, specified above, at top of run on straight, vertical runs of downspout piping 12 m (40 feet) long or more.
- D. Downspout Nozzle: The downspout nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout.

## **2.4 WATERPROOFING**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproofed caulked joint shall be provided at the top hub.

## **PART 3 - EXECUTION**

### **3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International code and these specifications.

- B. Branch piping shall be installed from the piping system and connect to all drains and outlets.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the Drawings, minimum horizontal slope shall be one inch for every 1.22 m (4 feet) of pipe length.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep  $\frac{1}{4}$  bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and  $\frac{1}{8}$  bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc

cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
2. Pipe sections with damaged threads shall be replaced with new sections of pipe.

### **3.3 PIPE HANGERS, SUPPORTS AND ACCESSORIES:**

- A. All piping shall be supported according to the International plumbing code, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  1. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  2. NPS 3 (DN 80): 1500 mm (60 inches) with 13 mm (1/2 inch) rod.
  3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.
  4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 19 mm (3/4 inch) rod.
- E. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates shall have the following characteristics:
  1. Solid or split unplated cast iron.
  2. All plates shall be provided with set screws.
  3. Height adjustable clevis type pipe hangers.
  4. Adjustable Floor Rests and Base Flanges shall be steel.
  5. Hanger Rods shall be low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  6. Riser Clamps shall be malleable iron or steel.
  7. Roller shall be cast iron.
  8. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gage steel. The shield shall be sized for the insulation.

F. Miscellaneous Materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.

G. Penetrations:

1. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

H. Piping shall conform to the following:

1. Storm Water Drain and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm (3 inches) and smaller	2%

I. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.

1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 35 kPa (5 psi) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
3. Final Tests: Either one of the following tests may be used.
  - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
  - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products

from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 22 31 11**

**WATER DEIONIZERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide portable exchange deionizer of a mixed bed design (on hard water trains in parallel), for use in treating wash water used for compressor cleaning system on combustion turbine generator (CTG). Confirm type and capacity with selected CTG manufacturer.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Preparation and finish painting: Section 09 91 00, PAINTING.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 26 32 14, COMBUSTION TURBINE GENERATOR.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Deionizer tank construction, coatings, linings, and access openings.
  - 2. Internal distribution system design.
  - 3. Pipe and fittings for interconnecting hose distribution between tanks and quick disconnect fittings..
  - 4. Control system.
  - 5. Exchange resin.
  - 6. Accessories including pressure gages and test kit.
  - 7. Performance data including normal and maximum flow and pressure drop. Certification that required performance will be achieved.

- C. Complete detailed layout, setting, arrangement, and installation drawings including electrical/pneumatic controls. Drawings shall also show all parts of the apparatus including relative positions, dimensions, and sizes and general arrangement of connecting piping.
- D. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 PROJECT CONDITIONS:**

- A. Influent Water Analysis: (Shall assume data provided in annual City of Palo Alto water quality report; available on City of Palo Alto web site: [www.cityofpaloalto.org](http://www.cityofpaloalto.org))
- B. Design Parameters:
  - 1. Normal System Flow and Pressure Drop: (.8 gpm@ 20 psi)
  - 2. Effluent Water Quality: >1 megohm/cm, <0.5 MG/L TDS as CaCO<sub>3</sub>.
  - 3. Daily Water Usage: 1600gallons per day
  - 4. Daily Hours of Water Demand: 20
  - 5. Operating Temperature Range: 45-100degrees F
  - 6. Operating Pressure Range (System): 0- 100psig
  - 7. Electrical Requirements: None.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - 1. A-A-694D Sodium Chloride, Technical
- C. American Society of Mechanical Engineers (ASME):
  - 1. B16.1-1998 Cast Iron Pipe Flanges and Flanged Fittings
  - 2. B16.3 - 2006 Malleable-Iron Threaded Fittings Classes 150 and 300



3. B40.100 - 2005 Pressure Gages and Gage Attachments
  4. Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, 2007
- D. ASTM International (ASTM):
1. A53/A53M - 07 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
  2. D2665-04ae2 Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Piping and Fittings.
- E. American Water Works Association (AWWA):
1. B300 - 10 Hypochlorites
  2. B301 - 10 Liquid Chlorine
  3. C651 - 05 Disinfecting Water Mains
- F. National Electrical Manufacturers Association (NEMA):
1. ICS-6-1993(R2006) Industrial Control and Systems: Enclosures
- G. Department of Health and Human Services, Food and Drug Administration (FDA):
1. CFR 21, Chapter 1, Part 173.25, Ion-Exchange Resins
  2. CFR 21, Chapter 1, Part 175.300, Resinous and Polymeric Coatings

## **PART 2 - PRODUCTS**

### **2.1 DEIONIZING SYSTEM**

- A. Vertical pressure type deionization system complete with pressure vessels and deionizing resin. The system will be of an approved design as fabricated by a manufacturer regularly engaged in the production of water treatment equipment. All equipment and material will be supplied in compliance with the specifications as intended for a complete and operational system.
- B. Qualified manufacturers of deionizer equipment must be engaged in the manufacture of this equipment for a period of not less than fifteen (15) years.
- C. The basis of design is a portable exchange Deionizer Mixed-Bed on Hard Water deionization system.
- D. The purpose of the deionization system shall be to reduce the total dissolved solids from a known water supply so that the specific resistance of the water is not less than 1 megohm/cm, when the system is operated at 3.0 gpm and in accordance with the operating instructions. The system shall be capable of supplying 4674.2 gallons of deionized water between regenerations based on the influent water analysis listed in this specification.

- E. The systems performance is rated at a design flow rate of 3.0 gpm with a rated pressure drop of 18.5 psi.
- F. Equipment:
  - 1. Deionizer Tanks: Each system shall include 4 tank(s). There shall be 4 bank(s) of tanks in parallel with 1 tank in each bank.
    - a. Tank Construction: Mixed-bed tank(s) shall be manufactured of blow molded ABS reinforced by a continuous roving glass filament overwrap. The tank bottom will be supported on a molded structural base.
    - b. Access Openings: Each tank will be equipped with openings for mineral filling and periodic inspection.
  - 2. Internal Distribution:
    - a. The upper distribution system shall be of the single point distributor type, constructed of a fine slotted strainer to dispense water evenly over the resin bed.
    - b. The lower distribution system shall be of the single point distributor type, constructed of a fine slotted strainer to provide even flow distribution through the resin bed.
  - 3. Pipe and Fittings: The tanks shall be connected via a interconnecting hose distribution system with quick disconnect fittings.
  - 4. Exchange Resin:
    - a. The mixed-bed resin shall be high capacity consisting of a 2:1 by volume mixture of a Type II strong base anion exchange resin and a strong acid cation exchange resin. It shall be stable of the entire pH range with good resistance to bead fracture from attrition or osmotic shock. Each cubic foot of resin will be capable of removing 27000.0 grains as calcium carbonate.
    - b. The system shall include 0.25 ft<sup>3</sup> of mixed-bed exchange resin per tank with a total of 1.0 ft<sup>3</sup> of mixed-bed resin for the system.
    - c. All resins shall be solid, of the proper particle size, and will contain no agglomerates, shells, plates or other shapes that might interfere with the normal function of the deionizer. The resins shall be manufactured to comply with the food additive regulation 21 CFR 173.25 as set forth by the USFDA.
  - 5. Accessories:
    - a. A quality indicator light, which will remain lit as long as the water quality is above the rating of the light.

## **2.2 EXTERNAL DEIONIZER PIPING**

- A. Pipe: ASTM A53, galvanized, Schedule 40.
- B. Fittings: Malleable iron, ASME B16.3, or coated cast iron, ASME B16.1, class 125.
- C. Flanges: ASME B16.1, Class 125.
- D. Threaded Joints: Shall be made with ends reamed out. Apply bituminous base lubricant or fluorocarbon resin tape to male threads only.

### **2.3 VALVES**

- A. Ball: Carbon steel body, stainless steel trim, reinforced Teflon seat and seal, full port, threaded ends.

### **2.4 PRESSURE GAGES**

- A. ASME B40.100, Grade A, 1 percent accuracy, 110 mm (4-1/2 inches) diameter, all metal case, bottom connected. White dials, black hands, graduated from 0 to 700 kPa (0 to 100 psi) and identity labeled. Provide gages with gage cocks at softener hard water inlet and soft water outlet to show pressure drop thru softener.

### **2.5 BACKFLOW PREVENTER**

- A. Provide on suction side of water deionizer serving cogen system. Parts shall be made of corrosion-resistant materials and shall be of heavy duty construction, 850 kPa (125 psi) class minimum. Units shall operate automatically on line pressure without any manual control or assistance. Failure of any part vital to prevention of backflow shall be indicated by a continuous discharge for relief valve opening. Moving parts shall be easily removed and replaced without disconnecting backflow preventer, shall operate on "reduced pressure" principle and incorporate a zone where pressure is always less than supply pressure. Pressure differentials shall be maintained by two spring-load vertical check valves and one spring-load, diaphragm-actuated, differential pressure relief valve.

### **2.6 WATER TESTING EQUIPMENT**

- A. Furnish water testing equipment in a portable cabinet specially made for the installed equipment.

## **PART 3 - EXECUTION**

### **3.1 REQUIRED TECHNICAL SERVICES**

- A. Provide services of a qualified manufacturer's representative to check complete installation for conformance to manufacturer's recommendation, put system into service, make all adjustments required for full conformance to design and specified requirements, and perform all demonstrations and tests.

### **3.2 FLUSHING AND DISINFECTING**

- A. Flush and disinfect new water lines and softener interiors in accordance with AWWA C651.
- B. Material:
  - 1. Liquid chlorine: AWWA B301.
  - 2. Hypochlorite: AWWA B300.

### **3.3      STARTUP AND TESTING**

- A.    Operating: Tests shall be run in presence of Contracting Officers Technical Representative (COTR) or Resident Engineer (RE). It will not be permitted, for testing purposes, to add to or subtract from exchange material used in apparatus, neither will any regenerating agent, other than the solution specified, be permitted.
- B.    The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

### **3.4      COMMISSIONING**

- A.    Provide commissioning documentation accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B.    Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.5      DEMONSTRATION AND TRAINING**

- A.    Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of units.
- B.    Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

### **3.6      CONSTRUCTION WASTE MANAGEMENT**

- A.    General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B.    To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 22 34 00**

**FUEL-FIRED DOMESTIC WATER HEATERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section describes the requirements for installing a complete domestic gas fired hot water heating system ready for operation including water heaters, thermometers, and all necessary accessories, connections, and equipment.

**1.2 RELATED WORK:**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS. Requirements for commissioning, systems readiness checklist, and training.
- D. Section 09 91 00, PAINTING: Preparation and finish painting.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 11 23, DOMESTIC WATER PUMPS: Circulating Pump.
- G. Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION: Heater Insulation.
- H. Section 23 10 00, FACILITY FUEL SYSTEMS.
- I. Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS
- J. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING, 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING, and 22 11 00, FACILITY WATER DISTRIBUTION: Piping, Fittings, Valves and Gages.
- K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENT FOR NON STRUCTURAL COMPONENTS: Seismic Restraint for Equipment.

**1.3 QUALITY ASSURANCE:**

- A. Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for efficiency performance:
  - 1. ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings" for commercial water heaters."

- B. Electrical components, devices and accessories shall be listed and label as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.
- C. ASME code construction shall be a vessel fabricated in compliance with the ASME boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Fabricate and label equipment components that will be in contract with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects"
- E. The gas fired domestic water heater shall conform to Section 13 05 41 on Seismic restraint requirements, withstanding Seismic movement without separation of any parts from the equipment when subjected to a Seismic event.

#### **1.4 SUBMITTALS:**

- A. Submit manufacturer's literature and data pertaining to the water heater in properly bound package, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Include the following as a minimum:
  - 1. Water Heaters.
  - 2. Pressure and Temperature Relief Valves.
  - 3. Thermometers.
  - 4. Pressure Gages.
  - 5. Vacuum Breakers.
- B. For each natural gas fired domestic hot water heater type and size, the following characteristics shall be submitted:
  - 1. Rated Capacities
  - 2. Operating characteristics
  - 3. Electrical characteristics
  - 4. Furnished specialties and accessories
  - 5. A form U-1 or other documentation stating compliance with the ASME Boiler and Pressure Vessel code.
- C. Shop drawings shall include wiring diagrams for power, signal and control functions.
- D. Seismic qualification certificates shall be submitted that details equipment anchorage components identifies equipment center of gravity with mounting and anchorage provisions, and whether the seismic qualification certificate is based on an actual test or calculations.
- E. The domestic water heater shall be certified and labeled by a testing agency.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted

item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society Of Sanitary Engineering (ASSE):
  1. 1005 Performance Requirements for Water Heater Drain Valves, 20 mm (3/4 inch) size
- C. American National Standard Institute (ANSI):
  1. Z21.10.3-04 Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings above 75000 Btu per hour, circulating and instantaneous.
  2. Z21.15A-01 Manually Operated Gas Valves for Appliances, Appliance connector Valves, and Hose End Valves
  3. Z21.18-07 Gas appliance Pressure Regulators
  4. Z21.20-05 Automatic Gas Ignition Systems and Components
  5. Z21.21-05 Automatic Valves for Gas Appliance
  6. Z21.22B-01 Relief Valves for Hot Water Supply systems
  7. Z21.66-96(R2001) Automatic Vent Damper Devices for Use With Gas Fired Appliances
- D. American Society of Mechanical Engineers (ASME):
  1. B1.20.1-83(R 2006) Pipe Threads, General Purpose(Inch)
  2. B16.5-03 Standard for Pipe Flanges and Flanged Fittings: NPS 3/4 through NPS 24.
  3. B16.24-06 Cast Copper Alloy Pipe Flanges and Flanged Fittings: classes 150, 300, 400, 600, 900, 1500, and 2500.
  4. PTC 25.3-02 Pressure Relief Devices
  5. Section IV-07 Boiler and Pressure Vessel Code; Section IV, Recommended Rules for the Care and Operation of Heating Boilers
  6. Section VIII D1-07 Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels Division 1 -Basic Coverage
- E. National Fire Protection Association (NFPA)
  1. 54-09 National Fuel Gas Code

## **1.6 AS-BUILT DOCUMENTATION**

- A. The electronic documentation and copies of the Operations and Maintenance Manual, approved submittals, shop drawings, and other closeout documentation shall be prepared by a computer software program complying with Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C 794d). The manufacturer or vendor of the software used to prepare the electronic documentation shall have a Voluntary Product Accessibility Template made available for review and included as part of the Operations and Maintenance Manual or closeout documentation. All available accessibility functions listed in the Voluntary Accessibility Template shall be enabled in the prepared electronic files. As Adobe Acrobat is a common industry format for such documentation, following the document, "Creating Accessible Adobe PDF files, A Guide for Document Authors" that is maintained and made available by Adobe free of charge is recommended."
- B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- C. Four sets of operation and maintenance data updated to include submittal review comments shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

## **PART 2 - PRODUCTS**

### **2.1 ATMOSPHERIC GAS FIRED, STORAGE DOMESTIC WATER HEATERS:**

- A. The gas fired domestic water heater shall comply with ANSI Z21.10.3.
- B. The water heater design shall provide a combustion efficiency of at least 80 percent at operating conditions.
- C. The tank Construction shall be ASME code Steel, glass lined, with 1035 kPa (160 psig) working pressure rating.
- D. The tapping (Fittings) shall be factory fabricated of materials compatible with the tank and in accordance with appropriate ASME standards for piping connection, pressure and temperature relief valve, pressure gauge, thermometer, drain valve, anode rods and controls. The tappings shall be:
  - 1. 50-mm or DN50 (2 inch) and smaller: Threaded ends according to ASME B1.20.1.



2. 65-mm or DN65 (2 1/2-inch) and larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges, and according to ASME B 16.24.
- E. The natural, gas fired burn shall include the following:
  1. Thermostatically adjustable.
  2. High temperature limit and low water cutoff devices for safety controls.
  3. Automatic ignition in accordance with ANSI Z21.20.
  4. Automatic damper in accordance with ANSI Z21.66. The automatic dampers shall be electrically operated, automatic vent damper device with size matching draft hood for 300,000 BTUH and below.
- F. Temperature Setting shall be set for a maximum water temperature of 55°C (130°F). The temperature setting shall be adjustable.
- G. The insulation shall surround the entire storage tank except connection and controls and shall comply with ASHRAE 90.1.
- H. The jacket shall be steel with enameled finish.
- I. The drain valve shall be corrosion resistant metal complying with ASSE 1005.
- J. The Combination Pressure and Temperature relief Valve shall be ANSI Z21.22 rated and constructed of all brass or bronze with a self-closing reseating valve.

## **2.2 DOMESTIC HOT WATER COMPRESSION TANKS**

- A. A steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as scheduled. The air pre charge shall be set to minimum system operating pressure at tank.
- B. The tappings shall be factory fabricated steel, welded to the tank and include ASME B1.20.1 pipe thread.
- C. The interior finish shall comply with NSF 61 barrier materials for potable water tank linings and the liner shall extend into and through the tank fittings and outlets.
- D. The air charging valve shall be factory installed.

## **2.3 HEAT TRAPS**

- A. Heat traps shall be installed in accordance with ASHRAE 90.1, latest edition.

## **2.4 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES**

- A. The combination temperature and pressure relief valves shall be ASME rated and stamped and include a relieving capacity at least as great as the heat

input and include a pressure setting less than the water heater's working pressure rating.

## **2.5 GAS SHUTOFF VALVES**

- A. The gas shutoff valve shall be manually operated conforming to ANSI Z21.15.
- B. An earthquake shear valve shall be installed.

## **2.6 GAS PRESSURE REGULATORS**

- A. The gas pressure regulator shall be appliance type, pressure rating matching inlet natural gas supply temperature, and conforming to ANSI Z21.18.

## **2.7 AUTOMATIC GAS VALVES**

- A. The automatic gas valves shall be appliance type, electrically operated, on-off automatic control, and conforming to ANSI Z21.21.

## **2.8 THERMOMETERS:**

- A. The thermometers shall be straight stem, iron case, red reflecting mercury thermometer or red liquid-filled thermometers, approximately 175 mm (7 inches) high, 4 to 115°C (40 to 240°F).

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION:**

- A. The water heaters shall be installed on concrete bases. Refer to Specification Section 03 30 00, CAST-IN-PLACE CONCRETE and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING
- B. The water heaters shall be installed level and plumb.
- C. The water heaters shall be installed and connected in accordance with manufacturer's written instructions.
- D. All pressure and temperature relief valves discharge shall be piped to a nearby floor drains.
- E. Thermometers shall be installed on the water heater inlet and outlet piping.
- F. Vent piping from gas-train pressure regulators and valves shall be piped to the outside of building and shall conform to NFPA 54.
- G. The thermostats shall be set for a maximum setting of 54°C (130°F).
- H. Shutoff valves shall be installed on the domestic water supply piping to the water heater and on the domestic hot water outlet piping.
- I. All manufacturers's required clearances shall be maintained.

- J. The natural gas fueled domestic water heaters shall be installed with seismic restraint devices.
- K. A combination temperature and pressure relief valve shall be installed at the top portion of the storage tank. The sensing element shall extend into the tank. The relief valve outlet drain piping shall discharge by positive air gap into a floor drain.
- L. Piping type heat traps shall be installed on the inlet and outlet piping of the electric domestic hot water heater storage tanks.
- M. Water heater drain piping shall be installed as indirect waste to spill by positive air gap into open drains or over floor drains. Hose end drain valves shall be installed at low points in water piping for natural gas fueled domestic hot water heaters without integral drains.
- N. The type B combustion vent shall be installed and sized according to the water heaters recommendations and extended through the roof or wall as allowed by the local fuel gas code or NFPA 54.

### **3.2 LEAKAGE TEST:**

- A. Before piping connections are made, the water heaters shall be test at a hydrostatic pressure of 1375 kPa (200 psi) and 1654 kPa (240 psi) for a unit with a MAWP of 1103 kPa (160 psi). Correct If any leakage is found on the water heater, the water heater shall be replaced with a new unit at no additional cost to the VA.

### **3.3 PERFORMANCE TEST:**

- A. All of the remote water outlets shall be tested to ensure a minimum of 49°C (120°F) and a maximum of 54°C (130°F) water flow at all times. If necessary, all corrections shall be made to balance the return water system or reset the thermostat to make the system comply with design requirements.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL

COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 22 40 00**

**PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Sealing between fixtures and other finish surfaces: Section 07 92 00, JOINT SEALANTS.
- E. Flush panel access doors: Section 08 31 13, ACCESS DOORS AND FRAMES.
- F. Through bolts: Section 10 21 13, TOILET COMPARTMENTS.
- G. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standard Institute (ANSI):
- C. The American Society of Mechanical Engineers (ASME):
  - 1. A112.6.1M-02(R2008) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
  - 2. A112.19.2M-03 Vitreous China Plumbing Fixtures
- D. American Society for Testing and Materials (ASTM):
  - 1. A276-2010 Stainless and Heat-Resisting Steel Bars and Shapes
  - 2. WW-P-541-E/GEN Plumbing Fixtures with Amendment 1
- E. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM AMP 500-505
  - 1. Metal Finishes Manual (1988)
- F. National Sanitation Foundation (NSF)/American National Standards Institute (ANSI):
  - 1. 61-2009 Drinking Water System Components-Health Effects
  - 2. American with Disabilities Act (A.D.A) Section 4-19.4 Exposed Pipes and Surfaces
  - 3. Environmental Protection Agency EPA PL 93-523 1974; A 1999) Safe Drinking Water Act.
  - 4. International Building Code, ICC IBC 2009.

### **PART 2 - PRODUCTS**

#### **2.1 STAINLESS STEEL**

- A. Corrosion-resistant Steel (CRS):
  - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
  - 2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.
- B. Die-cast zinc alloy products are prohibited.

#### **2.2 STOPS**

- A. Provide lock-shield loose key or screw driver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet

whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.

- B. Furnish keys for lock shield stops to Resident Engineer.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.

## **2.3 ESCUTCHEONS**

- A. Heavy type, chrome plated, with set screws. Provide for piping serving plumbing fixtures and at each wall, ceiling and floor penetrations in exposed finished locations and within cabinets and millwork.

## **2.4 LAMINAR FLOW CONTROL DEVICE**

- A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.
- B. Flow Control Restrictor:
  - 1. Capable of restricting flow from 95 ml/s to 110 ml/s (1.5 gpm to 1.7 gpm) for lavatories; 125 ml/s to 140 ml/s (2.0 gpm to 2.2 gpm) for sinks P-505 through P-520, P-524 and P-528; and 170 ml/s to 190 ml/s (2.75 gpm to 3.0 gpm) for dietary food preparation and rinse sinks or as specified.
  - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 kPa and 550 kPa (25 psi and 80 psi).
  - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.

## **2.5 CARRIERS**

- A. ASME/ANSI A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down.
- B. ASME/ANSI A112.6.1M, lavatory, chair carrier for thin wall construction steel plate as detailed on drawing. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.
- C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier

shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

## **2.6 WATER CLOSETS**

- A. (P-103) Water Closet (Wall Hung, ASME/ANSI A112.19.2M, Figure 9) office and industrial, elongated bowl, siphon jet 6 L (1.6 gallons) per flush, wall outlet. Top of seat shall be between 17 and 19 inches above finished floor.
  - 1. Seat: Institutional/Industrial, extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
  - 2. Fittings and Accessories: Gaskets - neoprene; bolts with chromium plated caps nuts and washers.
  - 3. Flush valve: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, battery powered active infra-red sensor for automatic operation with courtesy flush button for manual operation, sensor operated with manual override, water saver design 6 L (1.6 gallons) per flush with maximum 10 percent variance, 25 mm (1 inch) screwdriver back check angle stop with vandal resistant cap, adjustable tailpiece, a high back pressure vacuum breaker, spud coupling for 38 mm (1 1/2 inches) top spud, wall and spud flanges, and sweat solder adapter with cover tube and set screw wall flange. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification for semi-red brass. Seat bumpers shall be integral part of flush valve. Set centerline of inlet 292 mm (11 1/2 inches) above rim.

## **2.7 LAVATORIES**

- A. Dimensions for lavatories are specified, Length by width (distance from wall) and depth.
- B. Brass components in contact with water shall contain no more than 3 percent lead content by dry weight.
- C. (P-401) Lavatory (Single Lever Handle Control ASME/ANSI A112.19.2M, Figure 16) straight back, approximately 508 mm by 457 mm (20 inches by 18 inches) and a 102 mm (4 inches) maximum apron, first quality vitreous china. Punching for faucet on 102 mm (4 inches) centers. Set with rim 864 mm (34 inches) above finished floor.
  - 1. Faucet: Solid cast brass construction, vandal resistant, heavy-duty single lever handle, center set. Control shall be washerless ceramic disc cartridge type. Provide laminar flow control device, adjustable hot water limit stop, and vandal proof screws.
  - 2. Drain: Cast or wrought brass with flat grid strainer offset tailpiece, chrome plated. Provide cover per A.D.A 4-19.4.
  - 3. Stops: Angle type, see paragraph 2.2 Stops. Provide cover per A.D.A 4-19.4.



4. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extensions to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall. Provide cover per A.D.A 4-19.4.

## **2.8 EMERGENCY FIXTURES**

### **A. (P-707) Emergency Shower and Eye and Face Wash (Free Standing):**

1. Shower Head: Polished chrome plated, 203 mm (8 inches) in diameter, install head 2134 mm (84 inches) above floor. Equip with stay-open ball valve, chrome plated. Operate valve with 610 mm (24 inches) stainless steel pull-rod with triangle handle. Pull-down opens valve; push-up closes valve.
2. Emergency Eye and Face Wash: CRS receptor. Equipment with a 13 mm (1/2 inch) stay open ball valve operated by push flag handle. Mount eye and face wash spray heads 1067 mm (42 inches) above finished floor.
3. Shower head and emergency eye and face wash shall be mounted to stanchion with floor flange through floor waste connection and P-trap. Paint stanchion same color as room interior.
4. Provide with thermostatic mixing valve meeting ANSI/ISEA Z358.1-2004.

### **B. (P-711) Emergency Shower and Eye and Face Wash (Recessed Drench Shower and Eye/Face Wash):**

1. Shower Head and Shower Valve: Mount valve in hinged cabinet with access door, Shower head: Polished chrome plated, 273 mm (10.75 inches) in diameter, install head 2134 mm (84 inches) above floor. Provide shower head extension tailpiece where necessary. Equip with stay-open, chrome plated lever handle actuated ball valve, Push-up handle opens valve; push-down handle closes valve.
2. Emergency Eye and Face Wash: CRS receptor. Equip with a 13 mm (1/2 inch) stay open ball valve operated by pulling down the recessed door handle. Mount eye and face wash spray heads 1067 mm (42 inches) above finished floor.
3. Eye wash and face wash receptor shall be complete with drain plug with perforated strainer, P-trap and waste connection to wall with escutcheon.
4. Provide with thermostatic mixing valve meeting ANSI/ISEA Z358.1-2004.

## **2.9 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES**

- ### **A. (P-804) Hose Bibb (Single Faucet, Wall Mounted to Concealed or Exposed Supply Pipe):** Cast or wrought copper alloy, single faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, mounted on wall 914 mm (36 inches) above floor to concealed supply pipe. Provide faucet with 19 mm (3/4 inch) hose coupling thread on spout and vacuum breaker. Four-arm handle on faucet shall be cast, formed or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have a bright finish.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00, JOINT SEALANTS.
- B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.
- C. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4 inch) diameter bolts, and to extend at least 76 mm (3 inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
- F. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4 inch) threaded studs, and shall extend at least 32 mm (1 1/4 inches) into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.
- I. Do not use aerators on lavatories and sinks.

#### **3.2 CLEANING**

- A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

#### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 05 10**

**COMMON WORK RESULTS FOR COGENERATION PLANT AND STEAM GENERATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23 related to cogeneration (combined heat and power) plant and associated steam generation.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. RE: Resident Engineer
- C. Boiler plant: The heat recovery steam generation and associated steam and condensate ancillary equipment and piping are contiguous, and located at the co-generation plant. Where boilers are noted within the body of the specification, assume it refers to the heat recovery steam generator located in the new co-generation plant building unless specifically referring to existing boilers, in which case it would mean the existing boilers in Building 40.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 31 20 00, EARTH MOVING: Excavation and Backfill
- G. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- H. Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- I. Section 05 50 00, METAL FABRICATIONS.

- J. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- K. Section 07 92 00, JOINT SEALANTS.
- L. Section 09 91 00, PAINTING.
- M. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- N. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.
- O. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT.
- P. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- Q. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.
- R. Section 23 08 11, DEMONSTRATIONS and TESTS FOR COGENERATION PLANT.
- S. Section 23 09 11, INSTRUMENTATION and CONTROL FOR COGENERATION PLANT.
- T. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- U. Section 23 10 00, FACILITY FUEL SYSTEMS.
- V. Section 23 11 23, FACILITY NATURAL-GAS PIPING.
- W. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.
- X. Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT.
- Y. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.
- Z. Section 23 52 35, HEAT RECOVERY STEAM GENERATOR.
- AA. Section 25 60 00, CHP PLANT CONTROL SYSTEM.
- BB. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- CC. Section 26 29 11, MOTOR STARTERS.

### **1.3 QUALITY ASSURANCE**

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC or steam boiler plant construction, as applicable.

- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
  - 1. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
- D. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
  - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
  - 3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Resident Engineer (RE).
  - 4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
  - 5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  - 6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  - 7. Asbestos products or equipment or materials containing asbestos shall not be used.
- E. Equipment Service Organizations:
  - 1. Boiler Plants: Service organizations, authorized and trained by the manufacturers of the equipment supplied, shall be located within 100 miles of the project. These organizations shall come to the site and provide acceptable service to restore boiler plant operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Submit names, mail and e-mail addresses and phone numbers of service personnel and organizations providing service under these conditions for (as applicable to the project): burners,

burner control systems, boiler control systems, pumps, critical instrumentation, computer workstation and programming.

- F. Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- G. Cogeneration Plant and Outside Steam Distribution Welding: Refer to Sections 23 21 11, COGENERATION PLANT PIPING SYSTEMS, and 33 63 00, STEAM ENERGY DISTRIBUTION.
- H. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.
  2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to: all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the Resident Engineer for resolution.
  3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.
- I. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.
- J. Seismic Requirements: See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Earthquake-resistive design shall comply with the referenced editions of the following:
1. VA Handbook H-18-8, Seismic Design Requirements
  2. IBC



3. ASCE-7

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- F. Submittal "Groups" for cogeneration plant work are defined in the following checklist:
  - 1. Group I: (Gas Turbine Generator's Combustion System and Auxiliaries):
    - a. Gas turbine Set.
    - b. Intake air system.
    - c. Exhaust system.
    - d. Lubrication oil.
    - e. Ventilation system.
    - f. Water wash system.
    - g. Acoustic enclosure.
    - h. Compressed air supply.
  - 2. Group II: (Generator and auxiliaries associated with gas turbine generator).
    - a. Electric generator.
    - b. Excitation system.
    - c. Wiring system.
    - d. Grounding.
    - e. Generator surge protection.
    - f. Current transformers.

- g. Neutral grounding resistors.
  - h. Generator control panel.
  - i. Motors.
  - j. Battery and battery charger.
- 3. Group III: Heat recovery steam generators, duct burner and motor controls, boiler accessories (trim), fuel valve trains, atomizing media valve trains, economizers and accessories (when provided), stacks and breeching.
- 4. Group IV (Burner Controls and Co-generation Plant Controls and Instrumentation): control system, duct burner management (flame safeguard) systems (may be included with Group III), flow measuring systems, control and instrument panels and accessories, feedwater deaerator and condensate storage tank water level control systems, instruments and accessories, computer workstation and software, instrumentation, tools.
- 5. Group VI (Condensate Transfer and Feedwater System):
  - a. Condensate transfer pumps, motors, accessories.
  - b. Water level control valves for feedwater deaerator.
  - c. Feedwater deaerator and storage tank and accessories.
  - d. Boiler feed pumps, couplings, motors, motor controls and accessories.
- 6. Group VII (Gas Compressor System)
  - a. Fuel gas compressor and motor
  - b. Separators
  - c. Lube oil system
  - d. After coolers, coalesce
  - e. Field instruments and controls
- G. Ungrouped submittal items for cogeneration plant, which may be submitted individually, include, but are not limited to:
  - 1. Pipe, valves and fittings identified as to service application.
  - 2. Strainers.
  - 3. Continuous blow-off heat recovery system.
  - 4. Emergency shut off valve - gas.
  - 5. Safety valves and drip pan ells.
  - 6. Temperature control valves, sensors.
  - 7. Steam pressure reducing valves and pilots.
  - 8. Continuous blow off control system, valves - HRSG.
  - 9. Sight flow indicators, oil and water.
  - 10. Steam traps with orifice sizes and pressure ratings.
  - 11. Steam exhaust silencer.
  - 12. Thermometers and pressure gauges and accessories.
  - 13. Chemical feeders.

14. Sample coolers.
  15. Blowdown tank and accessories.
  16. Gas pressure regulators, relief valves, and filters.
  17. Flexible connectors, hose, braided.
  18. Dielectric fittings and unions.
  19. Heating and ventilating equipment for rooms.
  20. Condensate pump sets.
  21. Vibration isolators - air, water, oil.
  22. Supports and braces for pipe, stacks, breeching; load, size, movement calculations.
  23. Pressure gauge test kit.
  24. Insulation, field-applied.
  25. Gas detection system. Seismic calculations and drawings indicating equipment and piping anchoring, reinforcement and bracing.
  26. Earthquake valves - gas.
- H. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided under Article CHANGES of Section 00 72 00, GENERAL CONDITIONS.
- I. Layout Drawings:
1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to Section 00 72 00, GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION.
  2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
  3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
  4. In addition, for HVAC systems, provide details of the following:
    - a. Mechanical equipment rooms.
    - b. Hangers, inserts, supports, and bracing.
    - c. Pipe sleeves.

- d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- J. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
  - 1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Resident Engineer.
  - 2. Submit electric motor data and variable speed drive data with the driven equipment.
  - 3. Equipment and materials identification.
  - 4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers. For boiler plants, refer to Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS, for additional requirements.
  - 5. Wall, floor, and ceiling plates.
- K. Maintenance Data and Operating Instructions:
  - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  - 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- L. Cogeneration Plant Maintenance Data and Operating Instructions:
  - 1. Provide four bound copies. Deliver to Resident Engineer not less than 30 days prior to completion of a phase or final inspection.
  - 2. Include all new equipment and all elements of each assembly.
  - 3. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, pump impeller size, other data.
  - 4. Manufacturer's installation, maintenance, repair, and operation instructions for each device. Include assembly drawings and parts lists. Include operating precautions and reasons for precautions.
  - 5. Lubrication instructions including type and quantity of lubricant.
  - 6. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications.
  - 7. Description of operating sequence including description of relay and interlock positions at each part of the sequence.
  - 8. Set points of all interlock devices.
  - 9. Trouble-shooting guide for control systems.
  - 10. Operation of the combustion control system.
  - 11. Emergency procedures.
  - 12. Control system programming information for parameters, such as set points, that do not require services of an experienced technician.

13. Step-by-Step written instructions that are specific for the system installed on testing all safety devices. The instructions should reference the most recent edition of the VHA BOILER PLANT SAFETY DEVICE TESTING MANUAL for each test. All safety devices listed in the manual shall be tested as a minimum.
- M. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.
- N. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standard Institute (ANSI):
  1. B31.1-2007 Power Piping
- C. Rubber Manufacturers Association (ANSI/RMA):
  1. IP-20-2007 Specifications for Drives Using Classical V-Belts and Sheaves
  2. IP-21-2009 Specifications for Drives Using Double-V (Hexagonal) Belts
- D. Air Movement and Control Association (AMCA):
  1. 410-96 Recommended Safety Practices for Air Moving Devices
- E. American Society of Civil Engineers (ASCE):
  1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- F. American Society of Mechanical Engineers (ASME):
  1. Boiler and Pressure Vessel Code (BPVC):
  2. Section I-2007 Power Boilers
  3. Section IX-2007 Welding and Brazing Qualifications
    - a. Code for Pressure Piping:
  4. B31.1-2007 Power Piping
- G. American Society for Testing and Materials (ASTM):

1. A36/A36M-05 Standard Specification for Carbon Structural Steel
  2. A575-96(2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
  3. E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials
  4. E119-07a Standard Test Methods for Fire Tests of Building Construction and Materials
- H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
1. SP-58-2009 Pipe Hangers and Supports-Materials, Design and Manufacture, Selection, Application, and Installation
  2. SP 69-2003 Pipe Hangers and Supports-Selection and Application
  3. SP 127-2001 Bracing for Piping Systems, Seismic - Wind - Dynamic, Design, Selection, Application
- I. National Electrical Manufacturers Association (NEMA):
1. MG-1-2009 Motors and Generators
- J. National Fire Protection Association (NFPA):
1. 54-09 National Fuel Gas Code
  2. 70-08 National Electrical Code
  3. 85-07 Boiler and Combustion Systems Hazards Code
  4. 101-09 Life Safety Code

#### **1.6 DELIVERY, STORAGE AND HANDLING**

- A. Protection of Equipment:
1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
  2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
  3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
  4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.
- B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. HRSG shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

#### **1.7 JOB CONDITIONS - WORK IN EXISTING BOILER PLANT**

- A. Plant Operation: Government employees will be continuously operating and managing all plant facilities, including temporary facilities, that serve the steam and condensate requirements of the medical center.
- B. Maintenance of Steam Supply and Condensate Return Service: Schedule all work to permit continuous steam and condensate service at pressures and flow rates as required by the medical center. At all times there shall be one spare boiler available and one spare pump for each service available, in addition to those required for serving the load demand. The spare boiler and pumps must be capable of handling the loads that may be imposed if the operating boiler or pump fails.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Resident Engineer during periods when the steam demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am during the non-heating season. Provide at least one week advance notice to the Resident Engineer.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Plant Working Environment: Maintain the architectural and structural integrity of the plant building and the working environment at all times. Maintain the interior of plant at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA.
- F. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the

equipment will then be under the control and operation of Government personnel.

- G. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.
  - 2. Constituent parts that are alike shall be products of a single manufacturer.
  - 3. Components shall be compatible with each other and with the total assembly for intended service.
  - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

### **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

### **2.3 BELT DRIVES**

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.



- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
  - 5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations) in millimeters and inches:
- I. Drive Types, Based on ARI 435:
  - 1. Provide adjustable-pitch drive as follows:
    - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
    - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
  - 2. Provide fixed-pitch drives for drives larger than those listed above.
  - 3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

## **2.4 DRIVE GUARDS**

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.

- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

## **2.5 LIFTING ATTACHMENTS**

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.6 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps shall be product of a single manufacturer.
- C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- E. Controller shall be provided with the following operating features and accessories:
  - 1. Suitable for variable torque load.
  - 2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses

## **2.8 CONTROLS AND INSTRUMENTATION**

- A. Cogeneration plant shall be provided with a PLC control for the combustion turbine generator system, heat recovery steam generator, and natural gas compressor, per Section 25 60 00, CHP PLANT CONTROL SYSTEM, which shall tie to the continuous emissions monitoring system in Section 26 57 00. The HVAC systems shall be controlled by a DDC control with all systems reporting to a common ECC onsite specified in Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM (FMCS).
- B. Electronic Systems: Provide complete, protected power supplies as specified. Power supplies shall protect computers, controls, instruments and accessories from damage due to spikes, surges, transients, and overloads in the incoming power supply. Provide all interconnections between elements of the system. Entire installation shall conform to NFPA 70.

## **2.9 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. Cogeneration Plant: Provide for all valves.
  - 2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 3. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
  - 4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

**2.10 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint form.

**2.11 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT.
- B. Pipe Hangers and Supports for Boiler Plant: Refer to Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.
- C. Supports for Roof Mounted Items:
1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- D. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- E. Attachment to Concrete Building Construction:
1. Concrete insert: MSS SP-58, Type 18.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition, and shall be tested and qualified for use in cracked concrete per ACI 355.2 and ICC-ES AC 193. Anchors to have a current ICC-ES report approved for cracked concrete (seismic) use under the 2006 IBC. Install anchors in accordance with the ICC-ES report and manufacturer's instructions.
  3. Power-driven fasteners: Not permitted.
- F. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8 inch) outside diameter.
- G. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 36 00, COMPOSITE METAL DECKING .
- H. Attachment to existing structure: Support from existing floor/roof frame.

- I. Attachment to Wood Construction: Wood screws or lag bolts.
- J. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- K. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
  - 1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  - 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- L. Supports for Piping Systems:
  - 1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
  - 2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
    - a. Standard clevis hanger: Type 1; provide locknut.
    - b. Riser clamps: Type 8.
    - c. Wall brackets: Types 31, 32 or 33.
    - d. Roller supports: Type 41, 43, 44 and 46.
    - e. Saddle support: Type 36, 37 or 38.
    - f. Turnbuckle: Types 13 or 15. Preinsulate.
    - g. U-bolt clamp: Type 24.
    - h. Copper Tube:
      - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
      - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
      - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
      - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.

- i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
  3. High and Medium Pressure Steam (MSS SP-58):
    - a. Provide eye rod or Type 17 eye nut near the upper attachment.
    - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
    - c. Piping with Vertical Expansion and Contraction:
      - 1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
      - 2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
  4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.
- M. Pre-insulated Calcium Silicate Shields:
  1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
    - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
  5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- N. Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.

## **2.12 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- H. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with sealant.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.13 PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

## **2.14 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

## **2.15 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.16 ASBESTOS**

- A. Materials containing asbestos are not permitted.

# **PART 3 - EXECUTION**

## **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.



- C. Boiler Control Panel Locations: Locate and orient panels so that operating personnel standing in front of boilers can view the control switches and displays on the panel face. Panels mounted on the sides near the front of fire tube boilers are acceptable.
- D. Boiler and Economizer Access Platforms: Arrange piping and equipment to allow access by a person standing on the platforms to all valves located above the boilers, to boiler manways located on top of the boilers, and to all economizer valves and access panels.
- E. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- F. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- G. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Resident Engineer where working area space is limited.
  - 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Resident Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Resident Engineer for approval.
  - 3. Do not penetrate membrane waterproofing.
- H. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- I. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- J. Electrical and Pneumatic Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- K. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment

against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

- L. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- M. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- N. Install steam piping expansion joints as per manufacturer's recommendations.
- O. Work in Existing Building:
  - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
  - 2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
  - 3. Plant Operation: Government employees will be continuously operating and managing all plant facilities, including temporary facilities, that serve the steam and condensate requirements of the medical center.
  - 4. Maintenance of Steam Supply and Condensate Return Service: Schedule all work to permit continuous steam and condensate service at pressures and flow rates as required by the medical center. At all times there shall be one spare boiler available and one spare pump for each service available, in addition to those required for serving the load demand. The spare boiler and pumps must be capable of handling the loads that may be imposed if the operating boiler or pump fails.
  - 5. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the Resident Engineer during periods when the steam demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am during the non-heating season. Provide at least one week advance notice to the Resident Engineer.
  - 6. Phasing of Work: Comply with all requirements shown on drawings or specified.
  - 7. Plant Working Environment: Maintain the architectural and structural integrity of the plant building and the working environment at all times. Maintain the interior of plant at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of

construction and demolition debris on all floor surfaces and on all equipment being operated by VA.

8. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

- P. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.

1. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

- Q. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

- R. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

### **3.2 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur

to personnel by contact with operating facilities. The requirements of Paragraph 3.1 apply.

- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

### **3.3 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Resident Engineer for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Resident Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.

- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
  - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
  - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.
- G. Floor Supports:
  - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
  - 2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
  - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
  - 4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.5 MECHANICAL DEMOLITION**

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Resident Engineer. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.

- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to Resident Engineer and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

### **3.6 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
  - 2. Material And Equipment Not To Be Painted Includes:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.

- g. Copper, brass, aluminum, stainless steel and bronze surfaces.
  - h. Valve stems and rotating shafts.
  - i. Pressure gauges and thermometers.
  - j. Glass.
  - k. Name plates.
- 3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
  - 4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
  - 5. Boilers, Burners, Fuel Trains and Accessories: Retain manufacturer's factory finish. Touch up or recoat as necessary to provide smooth, even-colored and even-textured finish.
  - 6. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
  - 7. Paint shall withstand the following temperatures without peeling or discoloration:
    - a. HRSG stack and breeching -- 65 degrees C (150 degrees F) on insulation jacket surface and 315 degrees C (600 degrees F) on metal surface of stacks and breeching.
    - b. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
    - c. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
  - 8. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

### **3.7 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.8 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Boiler Plant Instrumentation Panel: Refer to Section 23 09 11.
- D. Boiler Control Panels: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR COGENERATION PLANT
- E. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.9 MOTOR AND DRIVE ALIGNMENT**

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

### **3.10 LUBRICATION**

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Resident Engineer in unopened containers that are properly identified as to application.
- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

### **3.11 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.12 STARTUP AND TEMPORARY OPERATION**

- A. Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL



REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.13 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR COGENERATION PLANT, and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

### **3.14 DEMONSTRATIONS AND TESTS, TEMPORARY BOILER PLANT EQUIPMENT**

- A. Test prior to placing in service.
- B. Demonstrate to Resident Engineer the proper operation of all equipment, instruments, operating and safety controls, and devices.
- C. Demonstrate to Resident Engineer the proper operation of burners.
  - 1. Emissions within limits specified for new boilers on this project.
  - 2. Stable flame at all operating points with no pulsations.
  - 3. Smooth flame light off, with no delays, puffs or flashbacks.
  - 4. Turndown capability as specified.
- D. Develop full steam output capacity required.
- E. New Boilers Installed in Temporary Location:
  - 1. Perform all tests required by boiler specification.
  - 2. Perform complete retest after boiler is placed in its permanent location.

### **3.15 INSTRUCTIONS TO VA PERSONNEL**

- A. Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR COGENERATION PLANT.

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**SECTION 23 05 11**

**COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. RE: Resident Engineer
  - 4. COTR: Contracting Officer's Technical Representative.

**1.2 RELATED WORK**

- A. Section 00 72 00, GENERAL CONDITIONS.
- B. Section 01 00 00, GENERAL REQUIREMENTS.
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- D. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- E. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- F. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- G. Section 31 20 00, EARTH MOVING: Excavation and Backfill.
- H. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- I. Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- J. Section 05 50 00, METAL FABRICATIONS.
- K. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- L. Section 07 92 00, JOINT SEALANTS.
- M. Section 09 91 00, PAINTING.

- N. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- O. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.
- P. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- Q. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- R. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.
- S. Section 23 09 11, INSTRUMENTATION and CONTROL FOR COGENERATION PLANT.
- T. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.
- U. Section 23 10 00, FACILITY FUEL SYSTEMS.
- V. Section 23 11 23, FACILITY NATURAL-GAS PIPING.
- W. Section 23 21 13, HYDRONIC PIPING.
- X. Section 23 21 23, HYDRONIC PUMPS.
- Y. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.
- Z. Section 23 22 23, STEAM CONDENSATE PUMPS.
- AA. Section 23 23 00, REFRIGERANT PIPING.
- BB. Section 23 25 00, HVAC WATER TREATMENT.
- CC. Section 23 31 00, HVAC DUCTS and CASINGS.
- DD. Section 23 34 00, HVAC FANS.
- EE. Section 23 37 00, AIR OUTLETS and INLETS.
- FF. Section 23 40 00, HVAC AIR CLEANING DEVICES.
- GG. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.
- HH. Section 23 52 35, HEAT RECOVERY STEAM GENERATOR
- II. Section 23 64 00, PACKAGED WATER CHILLERS.
- JJ. Section 23 65 00, COOLING TOWERS.
- KK. Section 23 81 43, AIR-SOURCE UNITARY HEAT PUMPS.
- LL. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- MM. Section 26 29 11, MOTOR STARTERS.

### 1.3 QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
  - 1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
  - 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- D. Products Criteria:
  - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
  - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
  - 3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Resident Engineer.
  - 4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
  - 5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  - 6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on

equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

7. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.

F. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

G. Execution (Installation, Construction) Quality:

1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.
2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

H. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

I. Seismic Requirements:

1. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Earthquake-resistive design shall comply with the referenced editions of:
  - a. VA Handbook H-18-8, Seismic Design Requirements
  - b. IBC
  - c. ASCE-7
2. Where individual Division 23 sections call for seismic certification or qualification of equipment in accordance with ASCE 7-05, the contractor shall not assume that the equipment types and styles called

for in the drawings or specifications have been previously tested or approved in accordance with ASCE 7 requirements. If the exact equipment type or style is not available with a current certification, the contractor shall assume that shake testing will be required. If the contractor elects in lieu of shake testing to submit a similar product that does have certification or otherwise meets the requirements of the ASCE 7, the contractor assumes all costs associated with the similar product including but not limited to increased electrical and structural requirements, larger or increased amounts of piping and noise mitigation if approved by the resident engineer.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.
- F. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided under Article CHANGES of Section 00 72 00, GENERAL CONDITIONS.
- G. Layout Drawings:
  - 1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to Section 00 72 00, GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION.

2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
  3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
  4. In addition, for HVAC systems, provide details of the following:
    - a. Mechanical equipment rooms.
    - b. Hangers, inserts, supports, and bracing.
    - c. Pipe sleeves.
    - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- H. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Resident Engineer.
  2. Submit electric motor data and variable speed drive data with the driven equipment.
  3. Equipment and materials identification.
  4. Fire-stopping materials.
  5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.
- I. HVAC Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- J. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.
- K. LEED Submittals: Submit in accordance with Section 01 81 11.01.
2. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  3. LEED Product Data Submittal Form: Submit completed product data form



provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standard Institute (ANSI):
  - 1. B31.1-2007 Power Piping
- C. Rubber Manufacturers Association (ANSI/RMA):
  - 1. IP-20-2007 Specifications for Drives Using Classical V-Belts and Sheaves
  - 2. IP-21-2009 Specifications for Drives Using Double-V (Hexagonal) Belts
- D. Air Movement and Control Association (AMCA):
  - 1. 410-96 Recommended Safety Practices for Air Moving Devices
- E. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- F. American Society of Mechanical Engineers (ASME):
  - 1. Boiler and Pressure Vessel Code (BPVC):
    - a. Section I-2007 Power Boilers
  - 2. Section IX-2007 Welding and Brazing Qualifications
- G. Code for Pressure Piping:
  - 1. B31.1-2007 Power Piping
- H. American Society for Testing and Materials (ASTM):
  - 1. A36/A36M-08 Standard Specification for Carbon Structural Steel
  - 2. A575-96(2007) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
  - 3. E84-10 Standard Test Method for Surface Burning Characteristics of Building Materials
  - 4. E119-09c Standard Test Methods for Fire Tests of Building Construction and Materials
- I. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - 1. SP-58-2009 Pipe Hangers and Supports-Materials, Design and Manufacture, Selection, Application, and Installation
  - 2. SP 69-2003 Pipe Hangers and Supports-Selection and Application

3. SP 127-2001 Bracing for Piping Systems, Seismic - Wind - Dynamic, Design, Selection, Application

J. National Fire Protection Association (NFPA):

1. 70-08 National Electrical Code
2. 101-09 Life Safety Code

**1.6 DELIVERY, STORAGE AND HANDLING**

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

**1.7 JOB CONDITIONS - WORK IN EXISTING BUILDING**

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities that serve the medical center.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing

systems, will be permitted by the Resident Engineer during periods when the demands are not critical to the operation of the medical center. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable). Provide at least one week advance notice to the Resident Engineer.

- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA.
- F. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

## **PART 2 - PRODUCTS**

### **2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
  - 1. All components of an assembled unit need not be products of same manufacturer.
  - 2. Constituent parts that are alike shall be products of a single manufacturer.
  - 3. Components shall be compatible with each other and with the total assembly for intended service.
  - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

## **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

## **2.3 BELT DRIVES**

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
- I. Drive Types, Based on ARI 435:
  - 1. Provide adjustable-pitch drive as follows:
    - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
    - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
  - 2. Provide fixed-pitch drives for drives larger than those listed above.
  - 3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

## **2.4 DRIVE GUARDS**

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

## **2.5 LIFTING ATTACHMENTS**

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

## **2.6 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same

class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.

- C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- E. Controller shall be provided with the following operating features and accessories:
  - 1. Suitable for variable torque load.
  - 2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses.

## **2.8 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
  - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.

3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

## **2.9 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint form.

## **2.10 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. Supports for Roof Mounted Items:
  1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized metal framing channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
  1. Concrete insert: MSS SP-58, Type 18.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition, and shall be tested and qualified for use in cracked concrete per ACI 355.2 and ICC-ES AC 193. Anchors to have a current ICC-ES report approved for cracked concrete (seismic) use under the 2006 IBC. Install anchors in accordance with the ICC-ES report and manufacturer's instructions.
  3. Power-driven fasteners: Not permitted.
- E. Attachment to Steel Building Construction:
  1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.
- F. Attachment to Metal Pan or Deck: As required for materials specified in Section 05 36 00, COMPOSITE METAL DECKING.
- G. Attachment to existing structure: Support from existing floor/roof frame.

- H. Attachment to Wood Construction: Wood screws or lag bolts.
- I. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- J. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
  - 1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  - 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- K. Supports for Piping Systems:
  - 1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
  - 2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
    - a. Standard clevis hanger: Type 1; provide locknut.
    - b. Riser clamps: Type 8.
    - c. Wall brackets: Types 31, 32 or 33.
    - d. Roller supports: Type 41, 43, 44 and 46.
    - e. Saddle support: Type 36, 37 or 38.
    - f. Turnbuckle: Types 13 or 15. Preinsulate.
    - g. U-bolt clamp: Type 24.
    - h. Copper Tube:
      - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
      - 2) For vertical runs use epoxy painted or plastic coated riser clamps.
      - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
      - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.



- i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
  3. High and Medium Pressure Steam (MSS SP-58):
    - a. Provide eye rod or Type 17 eye nut near the upper attachment.
    - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
    - c. Piping with Vertical Expansion and Contraction:
      - 1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
      - 2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
  4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.
- L. Pre-insulated Calcium Silicate Shields:
  1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
    - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
  5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- M. Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.

## **2.11 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- H. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with sealant.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

## **2.12 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

## **2.13 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the Resident Engineer, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

#### **2.14 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

#### **2.15 ASBESTOS**

- A. Materials containing asbestos are not permitted.

### **PART 3 - EXECUTION**

#### **3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment electrical disconnect switches shall be located to be readily accessible and with operator at code-compliant height from finished floor.

Permanent platforms, steps, and ladders shall be provided as required where disconnects are installed at non-code-compliant heights.

- D. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Resident Engineer where working area space is limited.
  - 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Resident Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Resident Engineer for approval.
  - 3. Do not penetrate membrane waterproofing.
- G. Interconnection of Instrumentation or Control Devices: Generally, electrical interconnections are not shown but must be provided.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. Electrical Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- J. Protection and Cleaning:
  - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
  - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- K. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- L. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff

standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

M. Install steam piping expansion joints as per manufacturer's recommendations.

N. Work in Existing Building:

1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

O. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 ft.) above the equipment of to ceiling structure, whichever is lower (NFPA 70).

P. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

### **3.2 TEMPORARY PIPING AND EQUIPMENT**

A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.

B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All

piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Paragraph 3.1 apply.

- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

### **3.3 RIGGING**

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Resident Engineer for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### **3.4 PIPE AND EQUIPMENT SUPPORTS**

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Resident Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.

- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
  - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
  - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
  - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
  - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
  - 3. Tubing and capillary systems shall be supported in channel troughs.
- G. Floor Supports:
  - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
  - 2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
  - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
  - 4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.5 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks.

Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.

2. Material And Equipment Not To Be Painted Includes:
  - a. Motors, controllers, control switches, and safety switches.
  - b. Control and interlock devices.
  - c. Regulators.
  - d. Pressure reducing valves.
  - e. Control valves and thermostatic elements.
  - f. Lubrication devices and grease fittings.
  - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
  - h. Valve stems and rotating shafts.
  - i. Pressure gauges and thermometers.
  - j. Glass.
  - k. Name plates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Paint shall withstand the following temperatures without peeling or discoloration:
  - a. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
  - b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
6. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.7 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond



to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.8 MOTOR AND DRIVE ALIGNMENT**

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

### **3.9 LUBRICATION**

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Resident Engineer in unopened containers that are properly identified as to application.
- C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.11 STARTUP AND TEMPORARY OPERATION**

- A. Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

**3.12 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

**3.13 INSTRUCTIONS TO VA PERSONNEL**

- A. Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS, and, Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

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**SECTION 23 05 12**

**GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.

**1.2 RELATED WORK:**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.
- E. Section 26 29 11, MOTOR STARTERS: Starters, control and protection for motors.
- F. Section 26 24 19, MOTOR-CONTROL CENTERS: Multiple motor control assemblies, which include motor starters.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION.
- I. Section 23 21 23, HYDRONIC PUMPS.
- J. Section 23 22 23, STEAM CONDENSATE PUMPS.
- K. Section 23 34 00, HVAC FANS.
- L. Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT.
- M. Section 23 64 00, PACKAGED WATER CHILLERS.
- N. Section 23 65 00, COOLING TOWERS.
- O. Section 23 81 26, SPLIT-SYSTEM AIR CONDITIONERS.
- P. Section 23 23 00, REFRIGERANT PIPING.

### **1.3 SUBMITTALS:**

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Provide documentation to demonstrate compliance with drawings and specifications.
  - 2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
  - 1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
  - 1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

### **1.4 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - 1. MG 1-2006 Rev. 1 2009 Motors and Generators
  - 2. MG 2-2001 Rev. 1 2007 Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

- C. National Fire Protection Association (NFPA):
  - 1. 70-2008 National Electrical Code (NEC)
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. 112-04 Standard Test Procedure for Polyphase Induction Motors and Generators
- E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - 1. 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings

## **PART 2 - PRODUCTS**

### **2.1 MOTORS**

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.
- C. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
  - 1. Contractor's Option - Electrically Commutated motor (EC Type): Motor shall be brushless DC type specifically designed for applications with heavy duty ball bearings and electronic commutation. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.
- D. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
  - 1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- E. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
  - 2. Three phase:

- a. Motors connected to 208-volt systems: 200 volts.
  - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 208-230/460 volts, dual connection.
  - c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
  - d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
  - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- F. Number of phases shall be as follows:
1. Motors, less than 373 W (1/2 HP): Single phase.
  2. Motors, 373 W (1/2 HP) and larger: 3 phase.
  3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- G. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.
- H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- I. Motor Enclosures:
1. Shall be the NEMA types as specified and/or shown on the drawings.
  2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
    - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
    - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
    - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
  3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- J. Special Requirements:
1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the

- requirements of NFPA 70 without additional time or cost to the Government.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
  3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
    - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
    - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
    - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
  4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
  5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- K. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.
- L. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%

18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- M. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

#### **3.2 FIELD TESTS**

- A. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.
- B. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- C. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

#### **3.3 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL



COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 05 41**

**NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Noise criteria, vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete inertia bases.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- G. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.
- H. Section 23 31 00, HVAC DUCTS and CASINGS: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- I. SECTION 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: requirements for sound and vibration tests.
- J. SECTION 23 37 00, AIR OUTLETS and INLETS: noise requirements for grilles.
- K. SECTION 23 21 23, HYDRONIC PUMPS: vibration isolation requirements for pumps.
- L. SECTION 23 05 51, NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT..
- M. SECTION 23 34 00, HVAC FANS: sound and vibration isolation requirements for fans.

- N. SECTION 23 65 00, COOLING TOWERS: requirements for sound and vibration isolation for cooling towers.
- O. SECTION 26 32 13, ENGINE GENERATORS: requirements for sound and vibration isolation.

### 1.3 QUALITY ASSURANCE

- A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Noise Criteria:
  - 1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

Type Of Room	NC LEVEL
Control Room/Office	35
Co-gen Equipment Areas	See Section 26 32 14

- 2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the fore-going noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.
    - 3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
    - 4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
  - C. Seismic Restraint Requirements:
    - 1. Equipment:
      - a. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist seismic forces in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
      - b. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting seismic forces in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
    - 2. Piping: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.

D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

#### **1.4 SUBMITTALS**

A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturer's Literature and Data:

1. Vibration isolators:

- a. Floor mountings
- b. Hangers
- c. Snubbers
- d. Thrust restraints

2. Bases.

3. Seismic restraint provisions and bolting.

4. Acoustical enclosures.

C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements as shown on drawings.

E. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
  - 1. 2009 Fundamentals Handbook, Chapter 7, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):
  - 1. A307-04e01 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  - 2. B117-07a Standard Practice for Operating Salt Spray (Fog) Apparatus
  - 3. D2240-05(2010) Standard Test Method for Rubber Property - Durometer Hardness
- D. Occupational Safety and Health Administration (OSHA):
  - 1. 29 CFR 1910.95 Occupational Noise Exposure
- E. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- F. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's National Association (ANSI/SMACNA):
  - 1. 001-2008 Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition.
- G. International Code Council (ICC):
  - 1. 2009 IBC International Building Code.
- H. Department of Veterans Affairs (VA):
  - 1. H-18-8 2010 Seismic Design Requirements.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Elastomeric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.

- C. Exposure to weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with section 1609 of the International Building Code. A minimum wind velocity of 85 mph shall be employed. Use appropriate wind importance factor for Occupancy Category IV, for Critical Facilities.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

## **2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENT**

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment Size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment.

## **2.3 VIBRATION ISOLATORS**

- A. Floor Mountings:
  - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
  - 2. Captive Spring Mount for Seismic Restraint (Type SS):
    - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.
    - b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
  - 3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around

- restraining bolts to prevent mechanical short circuiting. Isolators shall be capable of resisting seismic forces per Section 13 05 41 SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, with a minimum vertical capacity of one times the weight of the equipment.
4. Seismic Pad (Type DS): Pads shall be natural rubber / neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
  6. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed 1/4' clear of bottom of hanger housing in operation to prevent spring from excessive upward travel
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.



## **2.4 BASES**

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

## **2.5 SOUND ATTENUATING UNITS**

- A. Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Vibration Isolation:
  - 1. No metal-to-metal contact will be permitted between fixed and floating parts.
  - 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.

3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
  4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
  5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
  6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.
- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

### **3.2 ADJUSTING**

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SELECTION GUIDE FOR VIBRATION ISOLATORS**

EQUIPMENT		ON GRADE			20 FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
REFRIGERATION MACHINES							
PACKAGED HERMETIC		0---	DS	0.3	---	SP	0.8
OPEN CENTRIFUGAL		B	DS	0.3	B	SP	0.8
COMPRESSORS AND VACUUM PUMPS							
UP THRU 1-1/2 HP		---	DS	0.8	---	DS	0.8
2 HP AND OVER:							
500 - 750 RPM		---	DS	0.8	---	SS	0.8
750 RPM & OVER		---	DS	0.8	---	SS	0.8
PUMPS							
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	DS	---
	2 HP & OVER	---	---	---	I	SS	0.8
LARGE INLINE	UP TO 25 HP	---	---	---	---	SS	0.75
	26 HP THRU 30 HP	---	---	---	---	SS	1.0
BASE MOUNTED	UP TO 10 HP	---	---	---	---	DS	---
	15 HP THRU 40 HP	I	SS	1.0	I	SS	1.0
	50 HP & OVER	I	SS	1.0	I	SS	1.0
ROOF FANS							
ABOVE OCCUPIED AREAS:							
5 HP & OVER		---	---	---	CB	SS	1.0
CENTRIFUGAL FANS							
UP TO 50 HP:							
UP TO 200 RPM		B	N	0.3	B	SS	2.5
201 - 300 RPM		B	N	0.3	B	SS	2.0
301 - 500 RPM		B	N	0.3	B	SS	2.0
501 RPM & OVER		B	N	0.3	B	SS	2.0
60 HP & OVER:							

UP TO 300 RPM	B	SS	2.0	I	SS	2.5
301 - 500 RPM	B	SS	2.0	I	SS	2.0
501 RPM & OVER	B	SS	1.0	I	SS	2.0
COOLING TOWERS						
UP TO 500 RPM	---	---	---	---	SP	2.5
501 RPM & OVER	---	---	---	---	SP	0.75
INTERNAL COMBUSTION ENGINES						
UP TO 25 HP	I	N	0.75	I	N	1.5
EQUIPMENT	ON GRADE			20FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
30 THRU 100 HP	I	N	0.75	I	N	1.5
125 HP & OVER	I	N	0.75	I	N	1.5
AIR HANDLING UNIT PACKAGES						
SUSPENDED:						
UP THRU 5 HP	---	---	---	---	H	1.0
7-1/2 HP & OVER						
UP TO 500 RPM	---	D	---	R	S	1.5
501 RPM & OVER	---	D	---	---	S, THR	0.8
FLOOR MOUNTED:						
UP THRU 5 HP	---	DS	---	---	SS	1.0
7-1/2 HP & OVER:						
UP TO 500 RPM	---	DS	---	R	SS, THR	1.5
501 RPM & OVER	---	D	---	---	S, THR	0.8
HEAT PUMPS						
ALL	---	SS	0.75	---	S	0.75
CONDENSING - UNITS						
ALL	---	SS	0.25	---	SS	0.75
IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)						
UP THRU 50 HP:						
UP TO 300 RPM	---	DS	---	R	SS	2.5
301 - 500 RPM	---	DS	---	R	SS	2.0
501 - & OVER	---	DS	---	---	S	1.0
60 HP AND OVER:						
301 - 500 RPM	R	SS	1.0	R	S	2.0
501 RPM & OVER	R	SS	1.0	R	S	2.0

## NOTES:

1. Suspended: Use "H" isolators of same deflection as floor mounted.

**SECTION 23 05 51**

**NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the application of noise and vibration control techniques to cogeneration plant rotating equipment including pumps, fans, compressors, motors and combustion turbine generators.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION.
- E. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: Vibration isolators.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Noise and Vibration Control Devices; include with the equipment submittals.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Boiler Manufacturers Association (ABMA):
  - 1. ABMA-BOILER 304-1995 Measurement of Sound from Steam Generators

#### **PART 2 - PRODUCTS (NOT USED)**

#### **PART 3 - EXECUTION**

##### **3.1 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT**

- A. Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain alignment.

##### **3.2 VIBRATION TESTS ON ROTATING EQUIPMENT**

- A. Perform vibration tests on all pumps, fans, compressors and drivers during the pretest of the equipment. Tests shall be conducted by an experienced technician in the presence of the Resident Engineer (RE).
- B. Perform tests at each bearing in axial, horizontal, and vertical positions.
- C. RMS vibration velocity shall not exceed 0.0025 m/s (0.10-inch per second). Correct the cause of excessive vibration and provide retest.
- D. Test instruments furnished by contractor:
  - 1. Portable, with output capability to print data.
  - 2. Frequency range, 600-150,000 CPM minimum.
  - 3. Amplitude range, 2.54 m/s (0-100 inches per second).
  - 4. Sensitivity, 0.00013 m/s (0.005-inch per second).
  - 5. Frequency filter "out" for tests.
- E. Submit tabulated vibration readings to the RE.

##### **3.3 SOUND LEVELS**

- A. Sound level limitations apply to all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, motors, turbines.
- B. Sound levels shall not exceed 85 DBA when measured 1400 mm (4.5-feet) above the floor and 910 mm (3-feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit

which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.

- C. Tests will be performed by the Government using a standard sound level meter on the "A" scale, slow response. At the option and expense of the Government, a testing company may be employed to conduct tests using methods conforming to the referenced ABMA publication.
- D. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.
  - 1. Submit all proposed modifications or replacements for review prior to starting the work.
  - 2. After completing the work, provide complete retest of equipment operation and performance.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

#### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 05 93**

**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems, interior and exterior chilled water, steam, condensate, and feedwater. TAB includes the following:
  - 1. Planning systematic TAB procedures.
  - 2. Design Review Report.
  - 3. Systems Inspection report.
  - 4. Duct Air Leakage test report.
  - 5. Systems Readiness Report.
  - 6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
  - 7. Vibration and sound measurements.
  - 8. Recording and reporting results.
- B. Definitions:
  - 1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of 2007 ASHRAE Handbook, "HVAC Applications".
  - 2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
  - 3. AABC: Associated Air Balance Council.
  - 4. NEBB: National Environmental Balancing Bureau.
  - 5. Hydronic Systems: Includes chilled water, condenser water, steam, condensate systems.
  - 6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
  - 7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.

- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANTS and STEAM GENERATION: General Mechanical Requirements.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General Mechanical Requirements.
- F. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise and Vibration Requirements.
- G. Section 23 07 11, HVAC, PLUMBING, AND COGENERATION PLANT INSULATION: Piping and Equipment Insulation.
- H. Section 23 64 00, PACKAGED WATER CHILLERS: Testing Refrigeration Equipment.
- I. Section 23 65 00, COOLING TOWERS: Cooling Tower Performance Testing.
- J. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.
- K. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM: Controls and Instrumentation Settings.
- L. Section 23 34 00, HVAC FANS
- M. Section 23 21 23, HYDRONIC PUMPS
- N. Section 23 22 23, STEAM CONDENSATE PUMPS
- O. Section 23 37 00, AIR OUTLETS AND INLETS
- P. Section 23 81 43, AIR-SOURCE UNITARY HEAT PUMPS
- Q. Section 23 21 13, HYDRONIC PIPING
- R. Section 23 52 35, HEAT RECOVERY STEAM GENERATOR
- S. Section 23 05 12 GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

### **1.3 QUALITY ASSURANCE**

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANTS and STEAM GENERATION, and Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- B. Qualifications:
  - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and

vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.

3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
  4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
    - a. Shall directly supervise all TAB work.
    - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
    - c. Would follow all TAB work through its satisfactory completion.
    - d. Shall provide final markings of settings of all HVAC adjustment devices.
    - e. Permanently mark location of duct test ports.
  5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing. The lead technician shall be certified by AABC or NEBB
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

D. Tab Criteria:

1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop values for pre-filters and after-filters.
  - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
  - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
  - c. Minimum outside air: 0 percent to plus 10 percent.
  - d. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
  - e. Chilled water and condenser water pumps: Minus 0 percent to plus 5 percent.
3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Resident Engineer) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by VA.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
  1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
  2. Systems inspection report on equipment and installation for

- conformance with design.
  - 3. Duct Air Leakage Test Report.
  - 4. Systems Readiness Report.
  - 5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
  - 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
  - 1. 2007 HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):
  - 1. 2002 AABC National Standards for Total System Balance
- D. National Environmental Balancing Bureau (NEBB):
  - 1. 7<sup>th</sup> Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
  - 2. 2<sup>nd</sup> Edition 2006 Procedural Standards for the Measurement of Sound and Vibration
  - 3. 3<sup>rd</sup> Edition 2009 Procedural Standards for Whole Building Systems Commissioning of New Construction
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - 1. 3<sup>rd</sup> Edition 2002 HVAC SYSTEMS Testing, Adjusting and Balancing

## **PART 2 - PRODUCTS**

### **2.1 PLUGS**

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

### **2.2 INSULATION REPAIR MATERIAL**

- A. See Section 23 07 11, HVAC and COGENERATION PLANT INSULATION Provide for repair of insulation removed or damaged for TAB work.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

#### **3.2 DESIGN REVIEW REPORT**

- A. The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

#### **3.3 SYSTEMS INSPECTION REPORT**

- A. Inspect equipment and installation for conformance with design.
- B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

#### **3.4 SYSTEM READINESS REPORT**

- A. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to resident engineer.
- B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.
- C. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

#### **3.5 TAB REPORTS**

- A. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.

- B. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval at no additional cost to the owner.
- C. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

### **3.6 TAB PROCEDURES**

- A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- C. Coordinate TAB procedures with existing systems and any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project. Return existing areas outside the work area to pre constructed conditions.
- D. Allow 21 days time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- E. Air Balance and Equipment Test: Include air handling units, fans, fan coil units and room diffusers/outlets/inlets.
  - 1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended pressure drop.
  - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANTS and STEAM GENERATION.
  - 3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
  - 4. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:
  - 1. Coordinate water chiller flow balancing with Section 23 64 00, PACKAGED WATER CHILLERS.
  - 2. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
  - 3. Primary-secondary (variable volume) systems: Coordinate TAB with

Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM. Balance systems at design water flow and then verify that variable flow controls function as designed.

4. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

### **3.7 VIBRATION TESTING**

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANTS and STEAM GENERATION . Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Resident Engineer.

### **3.8 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
  1. Take readings in all equipment rooms and control rooms.
  2. Provide cooling tower sound measurements. Refer to Section 23 65 00, COOLING TOWERS.
- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- C. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
  1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT:
    - a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
    - b. Measure octave band sound pressure levels with specified equipment "off."



- c. Measure octave band sound pressure levels with specified equipment "on."
- d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

- e. Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.
  - f. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
2. When sound power levels are specified:
    - a. Perform steps 1.a. thru 1.d., as above.
    - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
    - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 16 meters (50 feet) for sound level location.
  3. Where sound pressure levels are specified in terms of dB(A), as in Section 23 65 00, COOLING TOWERS, or on the Drawings, measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.

- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.
- F. Test readings for sound testing could go higher than 15 percent if determination is made by the Resident Engineer based on the recorded sound data.

### 3.9 MARKING OF SETTINGS

- A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

### 3.10 IDENTIFICATION OF TEST PORTS

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All

penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

### **3.11 PHASING**

- A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

### **3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.13 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -

**SECTION 23 07 11**

**HVAC AND COGENERATION PLANT INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. HVAC piping, ductwork and equipment, in and around buildings and cooling towers, including chilled water piping in trenches, tunnels, and vaults.
  - 2. Cogeneration plant mechanical systems but excluding outside steam distribution.
  - 3. Chilled water distribution in site distribution vaults, tunnels, and trenches.
  - 4. Steam and condensate/feedwater piping not covered in Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases, trenches/vaults and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Generator Building, Chiller Plant, Cogeneration Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, vaults, tunnels, pipe trenches, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-scrim-kraft facing.
  - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F); gas turbine generator and HRSG exhaust, breechings and stack temperature range 150-370 degrees C (300-700 degrees F) and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F).
  - 8. Density: kg/m<sup>3</sup> - kilograms per cubic meter (Pcf - pounds per cubic foot).
  - 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.

10. Thermal conductance: Heat flow rate through materials.
  - a. Flat surface: Watt per square meter (BTU per hour per square foot).
  - b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).
11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
13. HPS: High pressure steam 415 kPa (60 psig) and above.
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam 110 kPa (16 psig) thru 414 kPa (59 psig).
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam 103 kPa (15 psig) and below.
18. LPR: Low pressure steam condensate gravity return.
19. PC: Pumped condensate.
20. CPD: Condensate pump discharge.
21. R: Pump recirculation.
22. CW: Cold water.
23. SW: Soft water.
24. HPG: High pressure natural gas.
25. CH: Chilled water supply.
26. CHR: Chilled water return.
27. RS: Refrigerant suction.
28. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.

- E. Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION: General requirements pertaining to mechanical Boiler Plant work.
- F. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- G. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: Boiler plant piping.
- H. Section 23 21 13, HYDRONIC PIPING: Hot water and chilled water piping, and for underground cased piping insulation between central plant and TES tank.
- I. Section 23 21 23, HYDRONIC PUMPS
- J. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
- K. Section 23 22 23, STEAM CONDENSATE PUMPS
- L. Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT
- M. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS
- N. Section 23 64 00, PACKAGED WATER CHILLERS: Compressor, evaporator and piping.
- O. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant piping and fittings.
- P. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and equipment.
- Q. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.
- R. Section 23 52 35, HEAT RECOVERY STEAM GENERATOR.
- S. Section 26 32 13, ENGINE GENERATORS: Exhaust stacks and muffler.
- T. Section 26 32 14, COMBUSTION TURBINE GENERATOR.
- U. Section 23 85 00, THERMAL ENERGY STORAGE TANK SYSTEM: For tank insulation.
- V. Section 33 63 00 STEAM AND CHILLED WATER SITE DISTRIBUTION: Piping and equipment.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION.
- B. Criteria:
  - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

- a. Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2., shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.
- b. Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)
- c. The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.
- d. Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:
  - 1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors
  - 2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors
- e. Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.
- f. In no case shall the test temperature be below 121°C (250°F).
- g. Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.
- h. 4.3.3.5\* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.
- i. 4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.
- j. 4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.
- k. 4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262,

Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1. 4.3.10.2.6.2 Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.
- m. 4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.
- n. 4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.
- o. 5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:
  - 1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides
  - 2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*
2. Test methods: ASTM E84, UL 723, or NFPA 255.
3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:

1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
  - a. Insulation materials: Specify each type used and state surface burning characteristics.
  - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
  - c. Insulation accessory materials: Each type used.
  - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
  - e. Make reference to applicable specification paragraph numbers for coordination.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Samples:
  1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
  2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
  3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

#### **1.5 STORAGE AND HANDLING OF MATERIAL**

- A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
  1. L-P-535E (2)- 99 Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):



1. MIL-A-3316C (2)-90 Adhesives, Fire-Resistant, Thermal Insulation
2. MIL-A-24179A (1)-87 Adhesive, Flexible Unicellular-Plastic Thermal Insulation
3. MIL-C-19565C (1)-88 Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
4. MIL-C-20079H-87 Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

D. American Society for Testing and Materials (ASTM):

1. B209-06 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
2. C411-05 Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
3. C177-10 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
4. C449-07 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
5. C533-09 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
6. C534-08 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
7. C547-07 Standard Specification for Mineral Fiber pipe Insulation
8. C552-03 Standard Specification for Cellular Glass Thermal Insulation
9. C553-08 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
10. C591-12a Standard Specification for Unfaced Performed Rigid Cellular Polyisocyanurate Thermal Insulation
11. C612-10 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
12. C1126-04 Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
13. C1136-10 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
14. D1668-97a (2006) Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
15. E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials
16. E119-07a Standard Test Method for Fire Tests of Building Construction and Materials

E. National Fire Protection Association (NFPA):

1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
  2. 101-09 Life Safety Code
  3. 251-06 Standard methods of Tests of Fire Endurance of Building Construction Materials
  4. 255-06 Standard Method of tests of Surface Burning Characteristics of Building Materials
  5. 262-11 Standard Method of Test for Flame Travel and Smoke of Wires and Cables For Use In Air-Handling Spaces
- F. Underwriters Laboratories, Inc (UL):
1. 723-2003 (R2005) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
- G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
1. SP58-2009 Pipe Hangers and Supports Materials, Design, and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m<sup>3</sup> (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-3, Density 16 kg/m<sup>3</sup> (1 pcf), k = 0.045 (0.31) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

### **2.2 MINERAL WOOL OR REFRACTORY FIBER**

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

### **2.3 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, k = 0.021(0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121

degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

#### **2.4 CELLULAR GLASS CLOSED-CELL**

- A. Comply with Standard ASTM C177, C518, density 120 kg/m<sup>3</sup> (7.5 pcf) nominal, k = 0.033 (0.29) at 24 degrees C (75 degrees F).
- B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

#### **2.5 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV, K=0.027(0.19) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, type IV, K=0.027(0.19) at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

#### **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C177, C518, k = 0.039 (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

#### **2.7 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

<b>Insulation Characteristics</b>		
<b>ITEMS</b>	<b>TYPE I</b>	<b>TYPE II</b>
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m <sup>3</sup> (lb/ ft3)	232 (14.5)	288 (18)

Insulation Characteristics		
ITEMS	TYPE I	TYPE II
Thermal conductivity: Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

## 2.8 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type

III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.

- H. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- I. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

## **2.9 REMOVABLE INSULATION JACKETS**

- A. Insulation and Jacket:
1. Non-Asbestos Glass mat, type E needled fiber.
  2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
  3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
  4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

## **2.10 PIPE COVERING PROTECTION SADDLES**

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass insulation of the same thickness as adjacent insulation.

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation.

- C. Boiler Plant Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system.

#### **2.11 ADHESIVE, MASTIC, CEMENT**

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

#### **2.12 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or galvanized steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

#### **2.13 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.

- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **2.14 FLAME AND SMOKE**

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulation outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. Insulate PRVs, flow meters, strainer, flexible connectors, expansion bellows, and steam traps with removable insulation jackets.
- I. HVAC work not to be insulated:
  - 1. Internally insulated ductwork and air handling units.
  - 2. Relief air ducts (Economizer cycle exhaust air).
  - 3. Environmental exhaust air ducts and plenums, and ventilation exhaust air shafts.
  - 4. Equipment: Expansion tanks, flash tanks, hot water pumps, steam condensate pumps.
  - 5. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.
- J. Cogeneration plant work not to be insulated:
  - 1. Pipes, valves and fittings:
    - a. Gas fuel.
    - b. Compressed Air.
    - c. Flowmeter sensing piping and blowdown.
    - d. Level sensor piping and blowdown.
    - e. Tank drains.
    - f. Vents-tank, safety and back pressure valves except protective.
    - g. Continuous blowdown and boiler water sampling except protective.
    - h. Threaded valves.
    - i. Check valves.
    - j. Unions.
    - k. Orifice flanges.
    - l. Dielectric flanges and unions.
    - m. Steam header drains.
    - n. Non-return stop and check valve drains.
    - o. Pneumatic controls.
    - p. Pressure transmission to gages.
    - q. Piping in control panels.
    - r. Tube cleaning piping.
    - s. Chemical feed from pump-type feeders.



- t. Condensate piping from flash tank to condensate return pump.
- 2. HRSG:
  - a. Water column, piping and blowdown.
  - b. Auxiliary low water cutoff, piping and blowdown.
  - c. Remote water level indicators and piping blowdown.
  - d. Steam gage piping.
  - e. Safety valves and drip pan ells.
  - f. Water level sensors and piping except where required by equipment manufacturer.
  - g. Control piping and devices or interlocks.
  - h. Drum heads.
- 3. Equipment:
  - a. Condensate return pump units.
  - b. Vacuum return pump units.
  - c. Pumps-inlet to outlet.
  - d. Flash tanks.
  - e. Safety valves.
  - f. Water meters.
  - g. Air compressors and tanks.
  - h. Refrigerated or desiccant air drier.
  - i. Chemical feeders.
  - j. Boiler and feedwater sampler.
  - k. All nameplates.
- 4. Specialties:
  - a. Control valves-water and steam.
  - b. Level sensors-piping, valves and blowdown.
  - c. Back pressure regulators-oil and steam.
  - d. Strainers under 38 mm (1-1/2 inch) pipe size.
  - e. Ball joints except piping between joints.
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Provide vapor barrier jackets over insulation as follows:
  - 1. All piping and ductwork exposed to outdoor weather.
  - 2. All interior piping and ducts conveying fluids below ambient air temperature.

- N. Provide metal jackets over insulation as follows:
  - 1. All piping and ducts exposed to outdoor weather.
  - 2. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.
- O. Refer also to Section 23 52 35, HEAT RECOVERY STEAM GENERATOR (HRSG) for insulation of HRSG and ducting from turbine and downstream of HRSG.

### **3.2 INSULATION INSTALLATION**

- A. Mineral Fiber Board:
  - 1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
  - 2. Plain board:
    - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
    - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
    - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
    - d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
  - 3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and duct work exposed to outdoor weather:
    - a. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct and unlined air handling units.
    - b. 50 mm (2 inch) thick insulation faced with ASJ: Return air duct.
    - c. Outside air intake ducts: No insulation required.
    - d. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.

4. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with ASJ.
    - a. Chilled water pumps, water filter, chemical feeder pot or tank.
    - b. For TES tank refer to Section 23 85 00 THERMAL ENERGY STORAGE TANK SYSTEM.
  5. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
    - a. Convertors, air separators, steam condensate pump receivers.
    - b. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.
    - c. Domestic water heaters and hot water storage tanks (not factory insulated).
- B. Flexible Mineral Fiber Blanket:
1. Adhere insulation to metal with 75 mm (3 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
  2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
  3. Concealed supply air ductwork.
    - a. Above ceilings at a roof level, in attics, and duct work exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with FSK.
    - b. Above ceilings for other than roof level: 40 mm (1 1/2 inch) thick insulation faced with FSK.
  4. Concealed return air duct:
    - a. In attics (where not subject to damage) and where exposed to outdoor weather: 50mmmm (2 inch)thick insulation faced with FSK.
    - b. Above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK.
    - c. In interstitial spaces (where not subject to damage): 40 mm (1-1/2 inch thick insulation faced with FSK.
    - d. Concealed return air ductwork in other locations need not be insulated.
  5. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
  - a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
  - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
  - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
  - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
3. Nominal thickness in millimeters and inches specified in the schedule at the end of this section.

D. Rigid Cellular Phenolic Foam:

1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges.
7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a maximum water vapor permeance of 0.00 perms.
8. Condensation control insulation: Minimum 25 mm (1.0 inch) thick for all pipe sizes.
  - a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.

E. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
2. Direct buried refrigeration piping, chilled water supply and return in Chiller room or pipe trenches, vaults, and tunnels below grade, and DX piping above grade. Type II, factory jacketed with a 3 mm laminate jacketing consisting of 3000 mm x 3000 mm (10 ft x 10 ft) asphalt impregnated glass fabric, bituminous mastic and outside protective plastic film.
  - a. As scheduled at the end of this section for chilled water piping.
  - b. Underground piping: Apply insulation with joints tightly butted. Seal longitudinal self-sealing lap. Use field fabricated or factory made fittings. Seal butt joints and fitting with jacketing and vapor/weather barrier/coating and sealant/adhesive, as recommended by the insulation manufacturer for direct buried application. Use 100 mm (4 inch) wide strips to seal butt joints.
  - c. Provide expansion chambers for pipe loops, anchors and wall penetrations as recommended by the insulation manufacturer.
  - d. Underground insulation shall be inspected and approved by the Resident Engineer as follows:
    - 1) Insulation in place before coating.
    - 2) After coating.
  - e. Sand bed and backfill: Minimum 75 mm (3 inches) all around insulated pipe or tank, applied after coating has dried.
3. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.
4. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a water vapor permeability of 0.00 perms.

F. Polyisocyanurate Closed-Cell Rigid Insulation:

1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for exterior piping, equipment and ductwork for temperature up to 149 degree C (300 degree F).
2. Install insulation, vapor barrier and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor barrier integrity.
3. Install insulation with all joints tightly butted (except expansion joints in hot applications).
4. If insulation thickness exceeds 63 mm (2.5 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.

5. For cold applications, vapor barrier shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor barrier shall be used to attach the vapor barrier or jacketing. No wire ties capable of penetrating the vapor barrier shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
6. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.
7. For cold applications, the vapor barrier on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor barrier adhesive tape.
8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).
9. Underground piping: Follow instructions for above ground piping but the vapor retarder jacketing shall be 6 mil thick PVDC or minimum 30 mil thick rubberized bituminous membrane or as recommended by insulation manufacturer for specific application on direct buried pipe. Sand bed and backfill shall be a minimum of 150 mm (6 inches) all around insulated pipe.
10. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.
11. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph 1.3B. Refer to paragraph 3.1 for items not to be insulated.
12. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section.

G. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION.
  - c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may

be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.

3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section).
5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.
6. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
  - a. Chilled water pumps
  - b. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).
  - c. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.
  - d. Piping inside refrigerators and freezers: Provide heat tape under insulation.
7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.

H. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant. See paragraphs 3.3 through 3.4 for Boiler Plant Applications.
2. Engine Exhaust Insulation for Emergency Generator: Type II, Class D, 65 mm (2 1/2 inch) nominal thickness. Cover exhaust completely from engine through roof or wall construction, including muffler. Secure with 16 AWG galvanized annealed wire or 0.38 x 12 mm 0.015 x 1/2 IN wide galvanized bands on 300 mm 12 IN maximum centers. Anchor wire and bands to welded pins, clips or angles. Apply 25 mm 1 IN hex galvanized wire over insulation. Fill voids with 6 mm 1/4 IN insulating cement.

**3.3 APPLICATION - COGENERATION AND BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:**

- A. Includes boiler feedwater from existing boiler plant to HRSG.
- B. Includes trench and manhole/vault, tunnel pipe, valves, strainers and fittings not covered in Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION.
- C. Temperature range 120 to 230 degrees C (251 to 450 degrees F);
  1. Application; Steam service 110 kpa (16 psig nominal) and higher, high pressure condensate to trap assembly, HRSG bottom blowoff from HRSG to blowoff valve closest to HRSG.

2. Insulation and Jacket:
  - a. Calcium silicate for piping from zero to 1800 mm (6 feet) above cogeneration room floor, feedwater heater mezzanine floor or access platform and any floors or platforms on which tanks or pumps are located.
  - b. Mineral fiber for remaining locations.
  - c. ASJ with PVC premolded fitting coverings.
  - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on atomizing steam and condensate lines at HRSG and duct burners.
3. Thickness:

Nominal Thickness Of Calcium Silicate Insulation (Cogeneration Plant)	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	125 (5)
25 to 38 (1-1/4 to 1-1/2)	125 (5)
38 (1-1/2) and above	150 (6)

- D. Temperature range 100 to 121 degrees C (211 to 250 degrees F):
  1. Application: Steam service 103 kpa (15 psig) and below, trap assembly discharge piping, HRSG feedwater from feedwater heater to HRSG feed pump recirculation, feedwater heater overflow.
  2. Insulation and Jacket:
    - a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above cogeneration room floor, feedwater heater mezzanine floor and access platform, and any floors or access platforms on which tanks or pumps are located.
    - b. Mineral Fiber or rigid closed cell phenolic foam for remaining locations.
    - c. ASJ with PVC premolded fitting coverings.
    - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on condensate lines at HRSG and duct burners.
  3. Thickness-calciumsilicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	50 (2)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)



## 4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	38 (1.5)
38 (1-1/2) and above	75 (3)

## E. Temperature range 32 to 99 degrees C (90 to 211 degrees F):

1. Application: Pumped condensate, gravity and pumped heating returns, condensate transfer, condensate transfer pump recirculation, condensate return from convertors, heated water storage tanks, and feedwater to HRSG.
2. Insulation Jacket:
  - a. Calcium silicate for piping from zero to 1800 mm (six feet above cogeneration room floor, feedwater heater mezzanine floor and access platform and any floor or access platform on which tanks or pumps are located.
  - b. Mineral fiber or rigid closed-cell phenolic foam for remaining locations.
  - c. ASJ with PVC premolded fitting coverings.
3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)

## 4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness Of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	19 (0.75)
25 to 38 (1-1/4 to 1-1/2)	19 (0.75)
38 (1-1/2) and above	25 (1)

## F. Protective insulation to prevent personnel injury:

1. Application: Piping from zero to 1800 mm (6 feet) above all floors and access platforms including continuous blowoff, feedwater and HRSG water sample, blowoff tank vent, flash tank vents and condensator tank vent, shot-type chemical feed, HRSG bottom blowoff after valves, valve by-passes.

2. Minimum Insulation thickness: 25 mm (1 inch), or thickness as required by manufacturer to limit surface temperature to less than 120 deg. F.
3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at HRSG within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.

G. Installation:

1. At pipe supports, weld pipe covering protection saddles to pipe, except where MS-SP58, type 3 pipe clamps are utilized.
2. Insulation shall be firmly applied, joints butted tightly, mechanically fastened by stainless steel wires on 300 mm (12 inch) centers.
3. At support points, fill and thoroughly pack space between pipe covering protective saddle bearing area.
4. Terminate insulation and jacket hard and tight at anchor points.
5. Terminate insulation at piping facilities not insulated with a 45 degree chamfered section of insulating and finishing cement covered with jacket.
6. On calcium silicate, mineral fiber and rigid closed-cell phenolic foam systems, insulated flanged fittings, strainers and valves with sections of pipe insulation cut, fitted and arranged neatly and firmly wired in place. Fill all cracks, voids and coat outer surface with insulating cement. Install jacket. Provide similar construction on welded and threaded fittings on calcium silicate systems or use premolded fitting insulation.
7. On mineral fiber systems, insulate welded and threaded fittings more than 50 mm (2 inches) in diameter with compressed blanket insulation (minimum 2/1) and finish with jacket or PVC cover.
8. Insulate fittings 50 mm (2 inches) and smaller with mastic finishing material and cover with jacket.
9. Insulate valve bonnet up to valve side of bonnet flange to permit bonnet flange removal without disturbing insulation.
10. Install jacket smooth, tight and neatly finish all edges. Over wrap ASJ butt strips by 50 percent. Secure aluminum jacket with stainless steel bands 300 mm (12 inches) on center or aluminum screws on 200 mm (4 inch) centers.
11. Do not insulate basket removal flanges on strainers.

**3.4 APPLICATION-GAS TURBINE GENERATOR (CTG)/HEAT RECOVERY STEAM GENERATOR (HRSG) FLUE GAS SYSTEMS**

A. Temperature range 150 to 400 degrees C (300 to 750 degrees F):

1. Application: Transitions, stacks and breechings from turbine outlet to HRSG and from HRSG to stack outlet.

2. Thickness:
  - a. Single-wall duct systems: 100 mm (4 inches).
  - b. Double-wall factory-fabricated duct systems with air space between walls: 50mm (2 inches).
3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.

B. Insulating:

1. Provide attachment facilities such as angles, welded studs, clip angles.
2. Apply insulation with joints tightly butted and staggered. Seal joints with high temperature cement.
3. Provide metal corner beads.
4. Band insulation firmly in place to provide a smooth surface. Maximum band spacing shall not be more than 300 mm (12 inches).
5. Install jacket. All surfaces outside of building must be weather tight. At termination of stub stacks, provide metal closure system which is connected and sealed to perimeter of stack to prevent water penetration of insulation.

### 3.5 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### 3.6 CONSTRUCTION WASTE MANAGEMENT

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### 3.7 PIPE INSULATION SCHEDULE

- A. Provide insulation for piping systems as scheduled below:
- B. Includes chilled water piping and feedwater piping in trenches, tunnels, and vaults, but excludes steam piping in boiler/cogeneration plants, and excludes steam/condensate piping below grade and in tunnels, vaults, and trenches.

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
122-177 degrees C (251-350 degrees F) (HPS, MPS)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Rigid Cellular Phenolic Foam	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
38-94 degrees C (100-200 degrees F) (LPR, PC)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-99 degrees C (100-211 degrees F) (LPR, PC)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
39-99 degrees C (100-211 degrees F) (LPR, PC)	Polyiso-cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	----	----
38-94 degrees C (100-200 degrees F) (LPR, PC)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----

4-16 degrees C (40-60 degrees F) (CH, CHR including piping in trenches tunnels, and vaults below grade) (RS for DX refrigeration, above-ground only)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and including piping in trenches, tunnels, and vaults below grade)	Cellular Glass Closed-Cell	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
4-16 degrees C (40-60 degrees F) (CH, CHR and RS for DX refrigeration, including buried refrigerant piping))	Cellular Glass Closed-Cell	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH, CHR (where underground, and in trenches, tunnels, and vaults) (RS for buried DX refrigeration)	Polyiso-cyanurate Closed-Cell Rigid	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
4-16 degrees C (40-60 degrees F) (CH, CHR and RS for DX refrigeration)	Polyiso-cyanurate Closed-Cell Rigid (Exterior above grade Locations only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
(40-60 degrees F) (CH, CHR and RS for DX refrigeration)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

- - - E N D - - -



**SECTION 23 09 23**

**FACILITY MONITORING AND CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The FMCS shall integrate and tie together the existing ECC with the new building automation system for HVAC control and monitoring as well as interface with the CHP Control system serving the cogeneration plant the new chiller controls at the existing chilled water plant for the equipment and systems added under this contract, and any controls associated with the thermal energy storage system. Additionally it is the responsibility of the FMCS contractor to collect the data points related to the advanced utility metering system and provide for the required interface devices suitable for the VA's remote aggregator of this data.
  - 1. Data points for the advanced metering system include domestic water, steam consumption, condensate return, chilled water supply and cooling tower make-up, in addition to electrical metering described. For further information refer to Section 25 10 10, ADVANCED UTILITY METERING SYSTEM available in the Technical Information Library located on the VA's national web site ([www.va.gov/til/](http://www.va.gov/til/)).
  - 2. Mapping of the CHP monitoring to the ECC complete with appropriate graphic shall be the responsibility of this Section.
- B. It shall be the responsibility of the FMCS contractor to identify and providing internet connectivity, all planning and coordination of fiber and Ethernet, and providing all hardware and connections between locations.
- C. The FMCS shall include all building specific direct digital controls and monitoring for HVAC systems and equipment and other points noted on ECC Input/Output Schedule.
- D. The Facility Monitoring and Control System (FMCS) shall be a direct extension of and connected to the existing ECC system or operator workstation manufactured by Siemens - Apogee. Contact Dennis Thompson (510) 723-7708. The existing CPU/Monitor, printer, and other peripherals shall be used to form a single operator workstation. New system components shall be a direct extension of the existing Siemens Apogee systems currently managing operations for the VA Palo Alto Health Care System (VA Palo Alto and Menlo Park campuses) and equipment shall operate and function as one complete system including one database of control point objects and global control logic capabilities. Facility operators shall have complete operations and control capability over all systems, new and existing including; monitoring, trending, graphing, scheduling, alarm management, global point sharing, global strategy deployment, graphical operations interface and custom reporting as specified except the PLC SCADA system for the co-gen, which shall be stand alone as defined in Section 25 60 00- of CHP PLANT CONTROL SYSTEM, but monitored remotely through the ECC. Modify

the existing Siemens Apogee ECC, if necessary, to accommodate the additional control points.

1. Coordinate with the telecommunications sections to ensure adequate pathways exist for required communications links and cabling or provide for new distribution cabling and conduits.
- E. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
1. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and an Engineering Control Center. Provide a remote user using a standard web browser to access the control system graphics and change adjustable setpoints with the proper password.
  2. The direct-digital control system(s) shall be native BACnet. All new workstations, controllers, devices and components shall be listed by BACnet Testing Laboratories. All new workstations, controller, devices and components shall be accessible using a Web browser interface and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications, specifically shown on the design drawings and specifically requested otherwise by the VA.
    - a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
    - b. If used, gateways shall provide all object properties and read/write services shown on VA-approved interoperability schedules. Compliant gateway (and supporting installation and technical services) shall be provided by the Equipment Manufacturer for the following systems:
      - 1) Water-Cooled Chillers.
      - 2) VFD's
      - 3) Packaged HVAC equipment
  3. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.
  4. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the



control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.

5. The control system shall accommodate Engineering Control Center(s) and 5 Remote Users simultaneously, and the access to the system should be limited only by operator password.
- F. Some products are furnished but not installed by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the installation of the products. These products include the following:
1. Control valves.
  2. Flow switches.
  3. Flow meters.
  4. Sensor wells and sockets in piping.
  5. Terminal unit / controllers.
  6. Refrigerant leak detection system.
- G. Some products are installed but not furnished by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the procurement of the products. These products include the following:
1. Factory-furnished accessory thermostats and sensors furnished with unitary equipment.
- H. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the particulars of the products. These products include the following:
1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.
  2. Advanced utility metering systems. These systems may take information from the control system or its component meters and sensors. There is no command or control action from the advanced utility monitoring system on the control system however.
  3. Boiler and/or chiller controls. These controls, if not native BACnet, will require a BACnet Gateway provided by the equipment manufacturer.
  4. Terminal units' velocity sensors

5. Condenser water quality systems: condenser water high- and low-parts hydrogen (pH) alarms.
6. Unitary HVAC equipment (rooftop air conditioning units, split systems, packaged pumping stations controls. These include:
  - a. Discharge temperature control.
  - b. Economizer control.
  - c. Flowrate control.
  - d. Setpoint reset.
  - e. Time of day indexing.
  - f. Status alarm.
7. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway interface by the equipment manufacturer.
8. The following systems have limited control (as individually noted below and applicable to this project scope) from the ECC:
  - a. Constant temperature rooms: temperature out of acceptable range and status alarms.
  - b. Emergency generators: status alarms.
  - c. Domestic water heating systems: low temperature, high temperature and status alarms.
  - d. Elevators: status alarms.
  - e. Building lighting systems: on/off and scene control.
  - f. Process conveyors: on/off control.
  - g. Stormwater removal pumps: status alarm.
  - h. Sanitary sewage pumps: status alarm.

## I. Responsibility Table:

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
LAN conduits and raceway	23 09 23	23 09 23	N/A	N/A
Automatic dampers (not furnished with equipment)	23 09 23	23	N/A	N/A
Automatic damper actuators	23 09 23	23 09 23	23 09 23	23 09 23
Manual valves	23	23	N/A	N/A
Automatic valves	23 09 23	23	23 09 23	23 09 23
Pipe insertion devices and taps, flow and pressure stations.	23	23	N/A	N/A
Thermowells	23 09 23	23	N/A	N/A
Current Switches	23 09 23	23 09 23	23 09 23	N/A

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Control Relays	23 09 23	23 09 23	23 09 23	N/A
Power distribution system monitoring interfaces	23 09 23	23 09 23	23 09 23	26
Interface with chiller controls	23 09 23	23 09 23	23 09 23	26
Chiller controls interface with control system	23	23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Smoke detectors	28 31 00	28 31 00	28 31 00	28 31 00
Fire/Smoke Dampers	23	23	28 31 00	28 31 00
Smoke Dampers	23	23	28 31 00	28 31 00
Fire Dampers	23	23	N/A	N/A
Chiller/starter interlock wiring	N/A	N/A	26	26
Chiller Flow Switches	23	23	23	N/A
Interface with PLC Control System for CTG / Co-gen monitoring	23 09 23	23 09 23	23 09 23	26
Generator electrical output meter associated with CHP Control System	25 60 00	25 60 00	25 60 00	25 60 00
Steam Flow from HRSG	25 60 00	25 60 00	25 60 00	25 60 00
Electrical Input to gas generator associated with CHP Control System	25 60 00	25 60 00	25 60 00	25 60 00
Feedwater flow from new pump in Boiler House to HRSG	25 60 00	25 60 00	25 60 00	25 60 00
Primary Gas meter to CHP Plant	23 09 23	23 10 00	23 09 23	26
Gas Flow Meters for measuring gas flow to CTG and HRSG Duct Burner with CTG and tied to CTG Control System)	25 60 00	25 60 00	25 60 00	25 60 00
Water treatment system	23	23	23	26
LEL Detectors in CHP Plant	25 60 00	25 60 00	25 60 00	25 60 00
VFDs	23 09 23	26	23 09 23	26

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Refrigerant monitors	23 09 23	23 09 23	23 09 23	26
Chilled water flow meter at each chiller	23 09 23	23 21 13	23 09 23	26
Cooling Tower Make-up water meter	23 09 23	22 11 00	23 09 23	26
Condenser water flow from each cooling tower	23 09 23	23 21 13	23 09 23	26
Fire Alarm shutdown relay interlock wiring	28	28	28	26
Control system monitoring of fire alarm panel	28	28	23 09 23	28
Packaged Unit space-mounted controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Cooling Tower Vibration Switches	23	23	23 09 23	23 09 23
Cooling Tower Level Control Devices	23	23	23 09 23	23 09 23
Cooling Tower makeup water control devices	23	23	23 09 23	23 09 23
Starters, HOA switches	23	23	N/A	26

J. This facility's existing direct-digital control system is manufactured by Siemens Apogee and its ECC is located at (5) locations throughout the VAPA HCS campuses. The existing system's top-end communications is via VA Campus Intranet. The existing system's ECC panels and top-end controllers were installed in February 2012. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.

1. Upgrade (as necessary) the existing direct-digital control system's Siemens Apogee ECC to include all properties and services required by an ASHRAE Standard 135 BACnet B-AWS Profile. The upgraded ECC shall continue to communicate with the existing direct-digital control system's devices. The upgraded ECC shall communicate directly with the new native-BACnet devices over the existing control system's communications network without the use of a gateway. Provide programming converting the existing non-BACnet devices, objects and services to ASHRAE Standard 135 BACnet-complaint BIBBs. The contractor administered by this Section of the technical specifications shall provide all necessary investigation and site-specific programming to execute the interoperability schedules.

- a. The performance requirement for the combined system: the combined system shall operate and function as one complete system including one database of control point objects and global control logic capabilities. Facility operators shall have complete operations and control capability over all systems, new and existing including; monitoring, trending, graphing, scheduling, alarm management, global point sharing, global strategy deployment, graphical operations interface and custom reporting as specified.
  - K. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by Siemens Industry, Inc. (Siemens Apogee) and Siemens preselected controls service company. Unitary standalone systems including Unit Heaters, Cabinet Unit Heaters, Fan Coil Units, Base Board Heaters, thermal comfort ventilation fans, and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents. Application of standalone unitary controls is limited to at least those systems wherein remote monitoring, alarm and start-up are not necessary. Examples of such systems include:
    - 1. Light-switch-operated toilet exhaust
    - 2. Vestibule heater
    - 3. Mechanical or electrical room heating and ventilation.
  - L. The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system. Use electricity as the motive force for all damper and valve actuators, unless use of pneumatics as motive force is specifically granted by the VA.
- 1.2 RELATED WORK**
- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
  - B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
  - C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
  - D. Section 21 05 11, Common Work Results for Fire Suppression.
  - E. Section 22 11 23, Domestic Water Pumps.
  - F. Section 22 13 29, Sanitary Sewerage Pumps.
  - G. Section 22 15 00, General Service Compressed-Air Systems.
  - H. Section 22 34 00, Fuel-Fired Domestic Water Heaters.
  - I. Section 23 21 13, Hydronic Piping.

- J. Section 23 22 13, Steam and Condensate Heating Piping.
- K. Section 23 31 00, HVAC Ducts and Casings.
- L. Section 23 52 33, HEAT RECOVERY STEAM GENERATOR (HRSG).
- M. Section 23 64 00, Packaged Water Chillers.
- N. Section 23 81 26, SPLIT-SYSTEM AIR CONDITIONERS.
- O. Section 25 60 00, CHP PLANT CONTROL SYSTEM.
- P. Section 26 05 11, Requirements for Electrical Installations.
- Q. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below).
- R. Section 26 05 26, Grounding and Bonding for Electrical Systems.
- S. Section 26 05 33, Raceway and Boxes for Electrical Systems.
- T. Section 26 09 23, Lighting Controls.
- U. Section 26 27 26, Wiring Devices.
- V. Section 26 29 11, Motor Starters.
- W. Section 26 32 13, Engine Generators.
- X. Section 28 31 00, Detection and Alarm.

### **1.3 DEFINITION**

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- B. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.
- D. BACnet: A Data Communication Protocol for Building Automation and Control Networks , ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.
- E. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.

- F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may sue different LAN technologies.
- G. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
- H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- I. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.
- J. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.
- K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
- L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- M. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- N. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- O. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- P. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls
- Q. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- R. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- S. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

- T. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.
- U. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- V. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- W. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.
- X. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- Y. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Z. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- AA. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- BB. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- CC. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.



- DD. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- EE. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
- FF. GIF: Abbreviation of Graphic interchange format.
- GG. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- HH. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- II. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- JJ. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to "sockets" without confirmation of receipt. Transmission Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.
- KK. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- LL. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- MM. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- NN. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VA health-care facilities. It uses twisted-pair wiring for relatively low speed and low cost communication.
- OO. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
- PP. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

- QQ. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- RR. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
- SS. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
- TT. Operating system (OS): Software, which controls the execution of computer application programs.
- UU. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- VV. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- WW. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.
- XX. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.
- YY. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.
- ZZ. Repeater: A network component that connects two or more physical segments at the physical layer.
- AAA. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.
- BBB. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.
- CCC. Thermostats: devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

#### **1.4 QUALITY ASSURANCE**

##### **A. Criteria:**

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system.

The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.
2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

**1.5 PERFORMANCE**

A. The system shall conform to the following:

1. Graphic Display: The system shall display up to four (4) graphics on a single screen with a minimum of twenty (20) dynamic points per graphic. All current data shall be displayed within ten (10) seconds of the request.

2. **Graphic Refresh:** The system shall update all dynamic points with current data within eight (8) seconds. Data refresh shall be automatic, without operator intervention.
3. **Object Command:** The maximum time between the command of a binary object by the operator and the reaction by the device shall be two(2) seconds. Analog objects shall start to adjust within two (2) seconds.
4. **Object Scan:** All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior six (6) seconds.
5. **Alarm Response Time:** The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
6. **Program Execution Frequency:** Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. **Multiple Alarm Annunciations:** All workstations on the network shall receive alarms within five (5) seconds of each other.
8. **Performance:** Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
9. **Reporting Accuracy:** Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	$\pm 0.5^{\circ}\text{C}$ ( $\pm 1^{\circ}\text{F}$ )
Ducted air temperature	$\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ]
Outdoor air temperature	$\pm 1.0^{\circ}\text{C}$ [ $\pm 2^{\circ}\text{F}$ ]
Dew Point	$\pm 1.5^{\circ}\text{C}$ [ $\pm 3^{\circ}\text{F}$ ]
Water temperature	$\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ]
Relative humidity	$\pm 2\%$ RH
Water flow	$\pm 1\%$ of reading
Air flow (terminal)	$\pm 10\%$ of reading
Air flow (measuring stations)	$\pm 5\%$ of reading
Carbon Monoxide (CO)	$\pm 5\%$ of reading
Carbon Dioxide (CO <sub>2</sub> )	$\pm 50$ ppm
Air pressure (ducts)	$\pm 25$ Pa [ $\pm 0.1$ "w.c.]
Air pressure (space)	$\pm 0.3$ Pa [ $\pm 0.001$ "w.c.]
Water pressure	$\pm 2\%$ of full scale *Note 1
Electrical Power	$\pm 0.5\%$ of reading

Note 1: for both absolute and differential pressure

10. Control stability and accuracy: Control sequences shall maintain measured variable at setpoint within the following tolerances:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	$\pm 50$ Pa ( $\pm 0.2$ in. w.g.)	0-1.5 kPa (0-6 in. w.g.)
Air Pressure	$\pm 3$ Pa ( $\pm 0.01$ in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	$\pm 10\%$ of full scale	
Space Temperature	$\pm 1.0^{\circ}\text{C}$ ( $\pm 2.0^{\circ}\text{F}$ )	
Duct Temperature	$\pm 1.5^{\circ}\text{C}$ ( $\pm 3^{\circ}\text{F}$ )	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	$\pm 10$ kPa ( $\pm 1.5$ psi)	0-1 MPa (1-150 psi)
Fluid Pressure	$\pm 250$ Pa ( $\pm 1.0$ in. w.g.)	0-12.5 kPa (0-50 in. w.g.) differential

11. Extent of direct digital control: control design shall allow for at least the points indicated on the points lists on the drawings.

## 1.6 WARRANTY

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to or connect via (through password-limited access) VPN through the internet monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.
- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the

construction period until final commissioning, training of facility operators and acceptance of the project by VA.

#### **1.7 SUBMITTALS**

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
  - 1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
  - 2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
  - 3. Control dampers and control valves schedule, including the size and pressure drop.
  - 4. Control air-supply components, and computations for sizing compressors, receivers and main air-piping, if pneumatic controls are furnished.
  - 5. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.
  - 6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
  - 7. Color prints of proposed graphics with a list of points for display.
  - 8. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
  - 9. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  - 10. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall

show element name, type of device, manufacturer, model number, and product data sheet number.

11. Riser diagrams of wiring between central control unit and all control panels.
  12. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.
  13. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.
  14. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- D. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- E. Licenses: Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
- F. As Built Control Drawings:
1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
  2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
  3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.
- G. Operation and Maintenance (O/M) Manuals):
1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
  2. Include the following documentation:
    - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.

- b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
- c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
- d. Complete troubleshooting procedures and guidelines for all systems.
- e. Complete operating instructions for all systems.
- f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
- g. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.
- h. Licenses, guaranty, and other pertaining documents for all equipment and systems.

H. Submit Performance Report to Resident Engineer prior to final inspection.

#### **1.8 INSTRUCTIONS**

- A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below. Contractor shall also video tape instruction sessions noted below.
  - 1. First Phase: Formal instructions to the VA facilities personnel for a total of 16 hours, given in multiple training sessions (each no longer than four hours in length), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
  - 2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 16 hours of instructions, given in multiple training sessions (each no longer than four hours in length), to the VA facilities personnel.
  - 3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.
  - 4. Training shall be given by direct employees of the controls system subcontractor.



## **1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)**

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.
- B. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65°C (-40 to 150°F).
- C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

## **1.10 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 1. Standard 135-10 BACNET Building Automation and Control Networks
- C. Federal Communication Commission (FCC):
  - 1. Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.
- D. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. 802.3-11 Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks- Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access method and Physical Layer Specifications
- E. National Fire Protection Association (NFPA):
  - 1. 70-08 National Electric Code
  - 2. 262-11 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use In Air-Handling Spaces

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Spare parts shall be available for at least five years after completion of this contract.

## **2.2 CONTROLS SYSTEM ARCHITECTURE**

### **A. General**

1. The Controls Systems shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
2. The ECC, building controllers and principal communications network equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels - not "Clones" assembled by a third-party subcontractor.
3. The networks shall, at minimum, comprise, as necessary, the following:
  - a. A fixed ECC and a portable operator's terminal.
  - b. Network computer processing, data storage and BACnet-compliant communication equipment including Servers and digital data processors.
  - c. BACnet-compliant routers, bridges, switches, hubs, modems, gateways, interfaces and similar communication equipment.
  - d. Active processing BACnet-compliant building controllers connected to other BACnet-compliant controllers together with their power supplies and associated equipment.
  - e. Addressable elements, sensors, transducers and end devices.
  - f. Third-party equipment interfaces and gateways as described and required by the Contract Documents.
  - g. Other components required for a complete and working Control Systems as specified.

- B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.

### **C. Network Architecture**

1. The Controls communication network shall utilize BACnet communications protocol operating over a standard Ethernet LAN and operate at a minimum speed of 100 Mb/sec.
2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations. They may also utilize digital wireless technologies as appropriate to the application and if approved by the VA.
3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the VA.

### **D. Third Party Interfaces:**

1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades.

2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.

E. Servers:

1. Provide data storage server(s) to archive historical data including trends, alarm and event histories and transaction logs.
2. Equip these server(s) with the same software tool set that is located in the BACnet building controllers for system configuration and custom logic definition and color graphic configuration.
3. Access to all information on the data storage server(s) shall be through the same browser functionality used to access individual nodes. When logged onto a server the operator will be able to also interact with any other controller on the control system as required for the functional operation of the controls systems. The contractor administered by this Section of the technical specifications shall provide all necessary digital processor programmable data storage server(s).
4. These server(s) shall be utilized for controls systems application configuration, for archiving, reporting and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and similar. These server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.

## 2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
  1. The Data link / physical layer protocol (for communication) acceptable to the VA throughout its facilities is Ethernet (ISO 8802-3) and BACnet/IP.
  2. The MS/TP data link / physical layer protocol is not acceptable to the VA in any new BACnet network or sub-network in its healthcare or lab facilities.
- B. Each controller shall have a communication port for connection to an operator interface.
- C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.

- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
- E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.
- F. ECCs and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

#### **2.4 ENGINEERING CONTROL CENTER (ECC)**

- A. The ECC shall reside on a high-speed network with controllers as shown on system drawings. The ECC and each standard browser connected to server shall be able to access all system information.
- B. ECC and controllers shall communicate using BACnet protocol. ECC and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.
- C. Hardware: ECC shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.
  - 1. ECC shall be commercial standard with supporting 32- or 64-bit hardware (as required by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.
    - a. The hard drive shall be at the minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, and shall have sufficient memory to store:
      - 1) All required operator workstation software
      - 2) A DDC database at least twice the size of the delivered system database
      - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.

- b. Real-time clock:
    - 1) Accuracy: Plus or minus 1 minute per month.
    - 2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
    - 3) Clock shall function for one year without power.
    - 4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
  - c. Serial ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
  - d. Parallel port: Enhanced.
  - e. Sound card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
  - f. Color monitor: PC compatible, not less than 22 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
  - g. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
  - h. Mouse: Standard, compatible with installed software.
  - i. Removable disk storage: Include the following, each with appropriate controller:
    - 1) Minimum 1 TB removable hard disk, maximum average access time of 10 ms.
  - j. Network interface card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.
- 2. Cable modem: 42.88 MBit/s, DOCSIS 2.0 Certified, also backwards compatible with DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.
  - 3. Optical modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.
  - 4. Auto-dial modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
  - 5. Audible Alarm: Manufacturer's standard.
  - 6. Printers:
    - a. Provide a dedicated, minimum resolution 600 dpi, color laser printer, connected to the ECC through a USB interface.
      - 1) If a network printer is used instead of this dedicated printer, it shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.

- 2) RAM: 512 MB, minimum.
    - 3) Printing Speed: Minimum twenty six pages per minute (color); minimum 30 pages per minute (black/white).
    - 4) Paper Handling: Automatic sheet feeder with 250-sheet x 8.5 inch x 11 inch paper cassette and with automatic feed.
  - b. Provide a dedicated black/white tractor-feed dot matrix printer for status/alarm message printing, minimum 10 characters per inch, minimum 160 characters per second, connected to the ECC through a USB interface.
    - 1) Paper: One box of 2000 sheets of 8-1/2x11 multi-fold type printer paper.
7. RS-232 ASCII Interface
- a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
  - b. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
  - c. Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
  - d. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
  - e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - 1) NFPA 70, Type CMP.
    - 2) Flame Resistance: NFPA 262, Flame Test.
8. Self-contained uninterruptible power supply (UPS):
- a. Size: Provide a minimum of six hours of operation of ECC equipment, including two hours of alarm printer operation.
  - b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
  - c. Accessories:
    - 1) Transient voltage suppression.
    - 2) Input-harmonics reduction.
    - 3) Rectifier/charger.
    - 4) Battery disconnect device.
    - 5) Static bypass transfer switch.
    - 6) Internal maintenance bypass/isolation switch.
    - 7) External maintenance bypass/isolation switch.
    - 8) Output isolation transformer.

- 9) Remote UPS monitoring.
- 10) Battery monitoring.
- 11) Remote battery monitoring.

D. ECC Software:

1. Provide for automatic system database save and restore on the ECC's hard disk a copy of the current database of each Controller. This database shall be updated whenever a change is made in any system panel. In the event of a database loss in a building management panel, the ECC shall automatically restore the database for that panel. This capability may be disabled by the operator.
2. Provide for manual database save and restore. An operator with proper clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. Provide a method of configuring the system. This shall allow for future system changes or additions by users with proper clearance.
4. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications. Acceptable operating systems are Windows XP, Windows System 7, Linux, and UNIX.
5. System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
6. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
7. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
8. The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and

- understanding of the displays by authorized users at the ECC. The operating system shall be Windows XP or better, and shall support the third party software.
9. Provide graphical user software, which shall minimize the use of keyboard through the use of the mouse and "point and click" approach to menu selection.
  10. The software shall provide a multi-tasking type environment that will allow the user to run several applications simultaneously. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able automatically export data to and work in Microsoft Word, Excel, and other Windows based software programs, while concurrently on-line system alarms and monitoring information.
  11. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
  12. User access shall be protected by a flexible and Owner re-definable software-based password access protection. Password protection shall be multi-level and partition able to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.
  13. The system shall be completely field-programmable from the common operator's keyboard thus allowing hard disk storage of all data automatically. All programs for the CUs shall be able to be downloaded from the hard disk. The software shall provide the following functionality as a minimum:
    - a. Point database editing, storage and downloading of controller databases.
    - b. Scheduling and override of building environmental control systems.
    - c. Collection and analysis of historical data.
    - d. Alarm reporting, routing, messaging, and acknowledgement.
    - e. Definition and construction of dynamic color graphic displays.
    - f. Real-time graphical viewing and control of environment.
    - g. Scheduling trend reports.
    - h. Program editing.
    - i. Operating activity log and system security.
    - j. Transfer data to third party software.
  14. Provide functionality such that using the least amount of steps to initiate the desired event may perform any of the following simultaneously:
    - a. Dynamic color graphics and graphic control.
    - b. Alarm management.



- c. Event scheduling.
- d. Dynamic trend definition and presentation.
- e. Program and database editing.
- f. Each operator shall be required to log on to the system with a user name and password to view, edit or delete the data. System security shall be selectable for each operator, and the password shall be able to restrict the operator's access for viewing and changing the system programs. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a selected time.

15. Graphic Displays:

- a. The workstation shall allow the operator to access various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Graphic software shall permit the importing of AutoCAD or scanned pictures in the industry standard format (such as PCX, BMP, GIF, and JPEG) for use in the system.
- b. System Graphics shall be project specific and schematically correct for each system. (ie: coils, fans, dampers located per equipment supplied with project.) Standard system graphics that do not match equipment or system configurations are not acceptable. Operator shall have capability to manually operate the entire system from each graphic screen at the ECC. Each system graphic shall include a button/tab to a display of the applicable sequence of operation.
- c. Dynamic temperature values, humidity values, flow rates, and status indication shall be shown in their locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh values.
- d. Color shall be used to indicate status and change in status of the equipment. The state colors shall be user definable.
- e. A clipart library of HVAC equipment, such as chillers, boilers, air handling units, fans, terminal units, pumps, coils, standard ductwork, piping, valves and laboratory symbols shall be provided in the system. The operator shall have the ability to add custom symbols to the clipart library.
- f. A dynamic display of the site-specific architecture showing status of the controllers, the ECC and network shall be provided.
- g. The windowing environment of the workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of graphic associated with an alarm to be viewed without interrupting work in progress. The graphic system software shall also have the capability to split screen, half portion of the screen with graphical representation and the other half with sequence of operation of the same HVAC system.

16. Trend reports shall be generated on demand or pre-defined schedule and directed to monitor display, printers or disk. As a minimum, the system shall allow the operator to easily obtain the following types of reports:
  - a. A general list of all selected points in the network.
  - b. List of all points in the alarm.
  - c. List of all points in the override status.
  - d. List of all disabled points.
  - e. List of all points currently locked out.
  - f. List of user accounts and password access levels.
  - g. List of weekly schedules.
  - h. List of holiday programming.
  - i. List of limits and dead bands.
  - j. Custom reports.
  - k. System diagnostic reports, including, list of digital controllers on the network.
  - l. List of programs.
17. ASHRAE Standard 147 Report: Provide a daily report that shows the operating condition of each chiller as recommended by ASHRAE Standard 147. At a minimum, this report shall include:
  - a. Chilled water (or other secondary coolant) inlet and outlet temperature
  - b. Chilled water (or other secondary coolant) flow
  - c. Chilled water (or other secondary coolant) inlet and outlet pressures
  - d. Evaporator refrigerant pressure and temperature
  - e. Condenser refrigerant pressure and liquid temperature
  - f. Condenser water inlet and outlet temperatures
  - g. Condenser water flow
  - h. Refrigerant levels
  - i. Oil pressure and temperature
  - j. Oil level
  - k. Compressor refrigerant discharge temperature
  - l. Compressor refrigerant suction temperature
  - m. Addition of refrigerant
  - n. Addition of oil
  - o. Vibration levels or observation that vibration is not excessive
  - p. Motor amperes per phase
  - q. Motor volts per phase
  - r. PPM refrigerant monitor level
  - s. Purge exhaust time or discharge count
  - t. Ambient temperature (dry-bulb and wet-bulb)
  - u. Date and time logged

18. Electrical, Gas, and Weather Reports

- a. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter.
- b. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.
- c. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.
- d. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.

19. Scheduling and Override:

- a. Provide override access through menu selection from the graphical interface and through a function key.
- b. Provide a calendar type format for time-of-day scheduling and overrides of building control systems. Schedules reside in the ECC. The digital controllers shall ensure equipment time scheduling when the ECC is off-line. The ECC shall not be required to execute time scheduling. Provide the following spreadsheet graphics as a minimum:
  - 1) Weekly schedules.
  - 2) Zone schedules, minimum of 100 zones.
  - 3) Scheduling up to 365 days in advance.
  - 4) Scheduled reports to print at workstation.

20. Collection and Analysis of Historical Data:

- a. Provide trending capabilities that will allow the operator to monitor and store records of system activity over an extended period of time. Points may be trended automatically on time based intervals or change of value, both of which shall be user definable. The trend interval could be five (5) minutes to 120 hours. Trend data may be stored on hard disk for future diagnostic and reporting. Additionally trend data may be archived to network drives or removable disk media for off-site retrieval.
- b. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow pre-defined groups of up to 250 trended points to be easily accessible by other industry standard word processing and spreadsheet packages. The reports shall be time and date stamped and shall contain a report title and the name of the facility.
- c. System shall have the set up to generate spreadsheet reports to track energy usage and cost based on weekly or monthly interval, equipment run times, equipment efficiency, and/or building environmental conditions.

- d. Provide additional functionality that will allow the operator to view real time trend data on trend graph displays. A minimum of 20 points may be graphed regardless of whether they have been predefined for trending. In addition, the user may pause the graph and take snapshots of the screens to be stored on the workstation disk for future reference and trend analysis. Exact point values may be viewed and the graph may be printed. Operator shall be able to command points directly on the trend plot by double clicking on the point.
21. Alarm Management:
- a. Alarm routing shall allow the operator to send alarm notification to selected printers or operator workstation based on time of day, alarm severity, or point type.
  - b. Alarm notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. The critical alarms shall display on the screen at the time of its occurrence, while others shall display by clicking on their icon.
  - c. Alarm display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message in English language. The operator shall be able to sort out the alarms.
  - d. Alarm messages shall be customized for each point to display detailed instructions to the operator regarding actions to take in the event of an alarm.
  - e. An operator with proper security level access may acknowledge and clear the alarm. All that have not been cleared shall be archived at workstation disk.
22. Remote Communications: The system shall have the ability to dial out in the event of an alarm. Receivers shall include operator workstations, e-mail addresses, and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself.
23. System Configuration:
- a. Network control strategies shall not be restricted to a single digital controller, but shall be able to include data from all other network devices to allow the development of global control strategies.
  - b. Provide automatic backup and restore of all digital controller databases on the workstation hard disk. In addition to all backup data, all databases shall be performed while the workstation is on-line without disturbing other system operations.

## **2.5 PORTABLE OPERATOR'S TERMINAL (POT)**

- A. Provide a portable operator's terminal (POT) that shall be capable of accessing all system data. POT may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. POT shall communicate using BACnet protocol. POT may be connected to any point on the system network or it may be connected

directly to controllers using the BACnet PTP (Point-To-Point) Data Link/Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) BACnet Services. POT shall be an IBM-compatible notebook-style PC including all software and hardware required.

- B. Hardware: POT shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.

1. POT shall be commercial standard with supporting 32- or 64-bit hardware (as limited by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 500 GB 7200 rpm SATA hard drive with 16 MB cache, minimum 2GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, minimum 16 inch (diagonal) screen, 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector, 56,600 bps modem, an ASCII RS-232 interface, and a 16 speed high density DVD-RW+/- optical drive.

- C. Software: POT shall include software equal to the software on the ECC.

## **2.6 BACNET PROTOCOL ANALYZER**

- A. For ease of troubleshooting and maintenance, provide a BACnet protocol analyzer. Provide its associated fittings, cables and appurtenances, for connection to the communications network. The BACnet protocol analyzer shall be able to, at a minimum: capture and store to a file all data traffic on all network levels; measure bandwidth usage; filter out (ignore) selected traffic.

## **2.7 NETWORK AND DEVICE NAMING CONVENTION**

- A. Network Numbers

1. BACnet network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VA campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internet work.
2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:
  - a. FFF = Facility code (see below)
  - b. NN = 00-99 This allows up to 100 networks per facility or building

- B. Device Instances

1. BACnet allows 4194305 unique devices instances per BACnet internet work. Using Agency's unique device instances are formed as follows: "Dev #" = "FFFNNDD" where
  - a. FFF and N are as above and
  - b. DD = 00-99, this allows up to 100 devices per network.

2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
3. Facility code assignments:
  - a. 000-400 Building/facility number
  - b. Note that some facilities have a facility code with an alphabetic suffix to denote wings, related structures, etc. The suffix will be ignored. Network numbers for facility codes above 400 will be assigned in the range 000-399.

C. Device Names

1. Name the control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. The intent of the device naming is to be easily recognized. Names can be up to 254 characters in length, without embedded spaces. Provide the shortest descriptive, but unambiguous, name. For example, in building #123 prefix the number with a "B" followed by the building number, if there is only one chilled water pump "CHWP-1", a valid name would be "B123.CHWP. 1.STARTSTOP". If there are two pumps designated "CHWP-1", one in a basement mechanical room (Room 0001) and one in a penthouse mechanical room (Room PH01), the names could be "B123.R0001.CHWP.1. STARTSTOP " or " B123.RPH01.CHWP.1.STARTSTOP". In the case of unitary controllers, for example a VAV box controller, a name might be "B123.R101.VAV". These names should be used for the value of the "Object\_Name" property of the BACnet Device objects of the controllers involved so that the BACnet name and the EMCS name are the same.

## 2.8 BACNET DEVICES

- A. All BACnet Devices - controllers, gateways, routers, actuators and sensors shall conform to BACnet Device Profiles and shall be BACnet Testing Laboratories (BTL) -Listed as conforming to those Device Profiles. Protocol Implementation Conformance Statements (PICSs), describing the BACnet capabilities of the Devices shall be published and available of the Devices through links in the BTL website.
  1. BACnet Building Controllers, historically referred to as NACs, shall conform to the BACnet B-BC Device Profile, and shall be BTL-Listed as conforming to the B-BC Device Profile. The Device's PICS shall be submitted.
  2. BACnet Advanced Application Controllers shall conform to the BACnet B-AAC Device Profile, and shall be BTL-Listed as conforming to the B-AAC Device Profile. The Device's PICS shall be submitted.
  3. BACnet Application Specific Controllers shall conform to the BACnet B-ASC Device Profile, and shall be BTL-Listed as conforming to the B-ASC Device Profile. The Device's PICS shall be submitted.
  4. BACnet Smart Actuators shall conform to the BACnet B-SA Device Profile, and shall be BTL-Listed as conforming to the B-SA Device Profile. The Device's PICS shall be submitted.

5. BACnet Smart Sensors shall conform to the BACnet B-SS Device Profile, and shall be BTL-Listed as conforming to the B-SS Device Profile. The Device's PICS shall be submitted.
6. BACnet routers and gateways shall conform to the BACnet B-OTH Device Profile, and shall be BTL-Listed as conforming to the B-OTH Device Profile. The Device's PICS shall be submitted.

## **2.9 CONTROLLERS**

- A. General. Provide an adequate number of BTL-Listed B-BC building controllers and an adequate number of BTL-Listed B-AAC advanced application controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
  1. The controller shall have sufficient memory to support its operating system, database, and programming requirements.
  2. The building controller shall share data with the ECC and the other networked building controllers. The advanced application controller shall share data with its building controller and the other networked advanced application controllers.
  3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
  4. Controllers that perform scheduling shall have a real-time clock.
  5. The controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
    - a. Assume a predetermined failure mode, and
    - b. Generate an alarm notification.
  6. The controller shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute and Initiate) and Write (Execute and Initiate) Property services.
  7. Communication.
    - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
    - b. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
  8. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  9. Memory. The controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

10. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- B. Provide BTL-Listed B-ASC application specific controllers for each piece of equipment for which they are constructed. Application specific controllers shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute) Property service.
1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
  2. Each B-ASC will contain sufficient I/O capacity to control the target system.
  3. Communication.
    - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
    - b. Each controller shall reside on an ARCNET network using the ISO 8802-2 Data Link/Physical layer protocol for its communications.
    - c. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
  4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.
  6. Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
  7. Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.
- C. Direct Digital Controller Software
1. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.
  2. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the ECC.



3. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
4. All controllers shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
5. All DDC control loops shall be able to utilize any of the following control modes:
  - a. Two position (on-off, slow-fast) control.
  - b. Proportional control.
  - c. Proportional plus integral (PI) control.
  - d. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
  - e. Automatic tuning of control loops.
6. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
7. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the ECC or via a portable operator's terminal, when it is necessary, to access directly the programmable unit.
  - a. Power Demand Limiting (PDL): Power demand limiting program shall monitor the building power consumption and limit the consumption of electricity to prevent peak demand charges. PDL shall continuously track the electricity consumption from a pulse input generated at the kilowatt-hour/demand electric meter. PDL shall sample the meter data to continuously forecast the electric demand likely to be used during successive time intervals. If the forecast demand indicates that electricity usage will likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads. Once the demand load has met, loads that have been shed shall be restored and returned to normal mode. Control system shall be capable of demand limiting by resetting the HVAC system set points to reduce load while maintaining indoor air quality.

- b. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoors dampers. If the outdoor air dry bulb temperature and humidity fall below changeover set point the energy control center will modulate the dampers to provide 100 percent outdoor air. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any time.
- c. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.
- d. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall consider both outside weather conditions and inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. The program shall poll all zones served by the associated AHU and shall select the warmest and coolest zones. These shall be used in the start time calculation. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via the ECC.
- e. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
  - 1) Time, day.
  - 2) Commands such as on, off, auto.
  - 3) Time delays between successive commands.
  - 4) Manual overriding of each schedule.
  - 5) Allow operator intervention.
- f. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the ECC based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.

- g. Remote Communications: The system shall have the ability to dial out in the event of an alarm to the ECC and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.
- h. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.
- i. Chilled water Plant Operation: This program shall have the ability to sequence the multiple chillers to minimize energy consumption. The program shall provide sequence of operation as described on the drawings and include the following as a minimum:
  - 1) Automatic start/stop of chillers and auxiliaries in accordance with the sequence of operation shown on the drawings, while incorporating requirements and restraints, such as starting frequency of the equipment imposed by equipment manufacturers.
  - 2) Secondary chilled water pumps and controls.
  - 3) Generate chilled water plant load profiles for different seasons for use in forecasting efficient operating schedule.
  - 4) Cooling Tower Operation Program: The objective of cooling tower control is to optimize chiller/tower energy use within the equipment restraints and minimum condenser water temperature limit recommended by the equipment manufacturer. Maintain chilled water plant performance records and print reports at intervals selected by the operator. It shall be possible for the operator to change the set points and the operating schedule.
  - 5) The chilled water plant program shall display the following as a minimum:
    - a) Secondary chilled flow rate.
    - b) Secondary chilled water supply and return temperature.
    - c) Condenser water supply and return temperature.
    - d) Outdoor air dry bulb temperature.
    - e) Outdoor air wet bulb temperature.
    - f) Ton-hours of chilled water per day/month/year.
    - g) On-off status for each chiller.
    - h) Chilled water flow rate.
    - i) Chilled water supply and return temperature.
    - j) Operating set points-temperature and pressure.
    - k) Kilowatts and power factor.

- l) Current limit set point.
- m) Date and time.
- n) Operating or alarm status.
- o) Operating hours.

## **2.10 SENSORS AND FLOW METERS (AIR, WATER AND STEAM)**

- A. Sensors' and meters' measurements shall be read back to the DDC system, and shall be visible by the ECC.
- B. Provide data heads at each meter, converting analog and pulsed information to digital information. Data heads shall allow for up to 24 hours of data storage (including time stamp, measured value, and scaling factor).
  - 1. Each data head shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each data head shall have a communication port for connection to an operator interface.
  - 2. Environment: Data Head hardware shall be suitable for the conditions ranging from -29°C to 60°C (-20°F to 140°F). Data Heads used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at conditions ranging from -29°C to 60°C (-20°F to 140°F).
  - 3. Provide a local keypad and display for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.
  - 4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  - 5. Memory. The building controller shall maintain all BIOS and data in the event of a power loss for at least 72 hours.
  - 6. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- C. Temperature and Humidity Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
  - 1. Temperature Sensors: thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
    - a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
    - b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
    - c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on

- sensor cover, and communication port. Match room thermostats. Provide a tooled-access cover.
- 1) Public space sensor: setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Do not provide in-space User set-point adjustment. Provide an opaque keyed-entry cover if needed to restrict in-space User set-point adjustment.
- d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
- e. Room security sensors shall have stainless steel cover plate with insulated back and security screws.
- f. Wire: Twisted, shielded-pair cable.
- g. Output Signal: 4-20 ma.
- 2. Humidity Sensors: Bulk polymer sensing element type.
  - a. Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability.
  - b. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - c. 4-20 ma continuous output signal.
- D. Static Pressure Sensors: Non-directional, temperature compensated.
  - 1. 4-20 ma output signal.
  - 2. 0 to 5 inches wg for duct static pressure range.
  - 3. 0 to 0.25 inch wg for Building static pressure range.
- E. Water flow sensors(Meters):
  - 1. Application: Chilled water.
  - 2. Type: Insertion vortex type with retractable probe assembly and 2 inch full port gate valve.
    - a. Pipe size: 3 to 24 inches.
    - b. Retractor: ASME threaded, non-rising stem type with hand wheel.
    - c. Mounting connection: 2 inch 150 PSI flange.
    - d. Sensor assembly: Design for expected water flow and pipe size.
    - e. Seal: Teflon (PTFE).
  - 3. Controller:
    - a. Integral to unit.
    - b. Locally display flow rate and total.
    - c. Output flow signal to BMCS: Digital pulse type.
  - 4. Performance:
    - a. Turndown: 20:1
    - b. Response time: Adjustable from 1 to 100 seconds.
    - c. Power: 24 volt DC

5. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.
  6. Provide Bi-directional flow meter for use at the TES.
- F. Water Flow Sensors (Meters): shall be magnetic insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minus 1 mm (0.05 inch); wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
1. Application: Domestic water and steam condensate.
  2. Performance characteristics:
    - a. Ambient conditions: -40°C to 60°C (-40°F to 140°F), 5 to 100% humidity.
    - b. Operating conditions: 850 kPa (125 psig), 0°C to 120°C (30°F to 250°F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
    - c. Nominal range (turn down ratio): 10 to 1.
    - d. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet). Preamplifier for bi-directional flow measurement shall provide a directional contact closure from a relay mounted in the preamplifier.
    - e. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
    - f. Ambient temperature effects, less than 0.005 percent calibrated span per °C (°F) temperature change.
    - g. RFI effect - flow meter shall not be affected by RFI.
    - h. Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.
- G. Steam Flow Sensor/Transmitter:
1. Sensor: Vortex magnetic shedder incorporating wing type sensor and amplification technology for high signal-to-noise ratio, carbon steel body with 316 stainless steel working parts, 24 VDC power, NEMA 4 enclosure.
    - a. Ambient conditions, -40°C to 80°C (-40°F to 175°F).
    - b. Process conditions, 900 kPa (125 psig) saturated steam.
    - c. Turn down ratio, 20 to 1.
    - d. Output signal, 4-20 ma DC.
    - e. Processor/Transmitter, NEMA 4 enclosure with keypad program selector and six digit LCD output display of instantaneous flow

rate or totalized flow, solid state switch closure signal shall be provided to the nearest DDC panel for totalization.

- 1) Ambient conditions, -20°C to 50°C (0°F-120°F), 0 95 percent non-condensing RH.
  - 2) Power supply, 120 VAC, 60 hertz or 24 VDC.
  - 3) Internal battery, provided for 24-month retention of RAM contents when all other power sources are removed.
- f. Sensor on all steam lines shall be protected by pigtail siphons installed between the sensor and the line, and shall have an isolation valve installed between the sensor and pressure source.

H. Screw type flowmeters (No. 2 oil duty)

1. Meters shall have cast iron cases, nitrided steel spindles, Viton seals, threaded pipe connections, designed for pressure exceeding set pressure, plus 25 percent, of nearest upstream relief valve. Meters shall be rated for 121 degrees C (250 degrees F) if utilized for heated oil.
2. Provide a meter data head.
  - a. Meter Registers: Hermetically sealed flow computer with digital flow rate readout and digital register for totalizer with at least five digits located at meter, positioned for easy viewing. Provide a data head on the meter.
3. Performance:
  - a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1% of flow rate.
  - b. Flowmeter accuracy shall be no more than plus or minus 0.1%, over the required flow range. Flowmeter repeatability shall be no more than 0.2% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.
  - c. Minimum turndown capability shall be 10:1. Its maximum fluid pressure drop through meter shall be as scheduled.

I. Gas Flow Sensor(Meter):

1. In-line meter rated for 500 psig.
2. Accuracy shall be  $\pm 1\%$  of reading,  $\pm 2\%$  of full scale.
3. Temperature accuracy  $\pm 1.8$  deg F from -40 deg F to 250 deg F.
4. Factory calibrated to NSIT traceable standards.
5. Input power 24 VDC,  $\pm 10\%$ , 0.75 amp standard.
6. Outputs: Provide USB connector and configuration tool for remote process monitoring and data logging functions. Include isolated communication outputs for HART and RS485 Modbus.
7. Sensor shall be 316 stainless steel.
8. Enclosure shall be NEMA 4X (IP68), aluminum, with dual conduit entries with 3/4 inch NPT.

9. Retractor Assembly: 125 psi rated packing gland assembly, high pressure (crank) retractor (600 psi) as required for application.
  10. Explosion proof for Class 1, Div. 1, Groups B, C, D; non-incendive for Class 1, Div. 2, Groups A, B, C, D; and Class II & III, Div. 1, Groups E, F, G, indoor/outdoor, NEMA 4X.
- J. Flow switches:
1. Shall be either paddle or differential pressure type.
    - a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
    - b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.
- K. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

## **2.11 CONTROL CABLES**

- A. General:
1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
  2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
  3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
  4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
  5. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the VA. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
  6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.
- B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 21.



- C. Copper digital communication cable between the ECC and the B-BC and B-AAC controllers shall be 100BASE-TX Ethernet, Category 5e or 6, not less than minimum 24 American Wire Gauge (AWG) solid, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP), with thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, as specified in Section 27 15 00.
  - 1. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media.
- D. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

## **2.12 THERMOSTATS AND HUMIDISTATS**

- A. Room thermostats controlling unitary standalone heating and cooling devices not connected to the DDC system shall have three modes of operation (heating - null or dead band - cooling, or as otherwise indicated on Drawings). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats shall have satin chrome finish, setpoint range and temperature display and external adjustment:
  - 1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.
    - a. Public Space Thermostat: Public space thermostat shall have a thermistor sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.
    - b. Battery replacement without program loss.
- B. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- C. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element. Freezestats shall be manually-reset.
- D. Room Humidistats: Provide fully proportioning humidistat with adjustable throttling range for accuracy of settings and conservation. The humidistat shall have set point scales shown in percent of relative humidity located on the instrument. Systems showing moist/dry or high/low are not acceptable.

## **2.13 FINAL CONTROL ELEMENTS AND OPERATORS**

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.
- B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- C. Power Operated Control Dampers (other than VAV Boxes) are specified in Section 23 31 00, HVAC DUCTS AND CASINGS.
- D. Smoke Dampers and Combination Fire/Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS.
- E. Control Valves:
  - 1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
  - 2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
  - 3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
  - 4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
  - 5. Flow characteristics:
    - a. Three way modulating valves shall be globe pattern. Position versus flow relation shall be linear relation for steam or equal percentage for water flow control.
    - b. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
    - c. Two-way 2-position valves shall be ball, gate or butterfly type.
  - 6. Maximum pressure drop:
    - a. Two position steam control: 20 percent of inlet gauge pressure.
    - b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
    - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
  - 7. Two position water valves shall be line size.
- F. Damper and Valve Operators and Relays:
  - 1. Electric operator shall provide full modulating control of dampers and valves. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete

- closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
- a. Minimum valve closeoff pressure shall be equal to the system pump's dead-head pressure, minimum 50 psig for valves smaller than 4 inches.
2. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
    - a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
  3. See drawings for required control operation.

#### **2.14 AIR FLOW CONTROL**

- A. Airflow and static pressure shall be controlled via digital controllers with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be analog or pulse width modulating output signals. The controllers shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.
- B. Air Flow Measuring Station -- Electronic Thermal Type:
  1. Air Flow Sensor Probe:
    - a. Each air flow sensor shall contain two individual thermal sensing elements. One element shall determine the velocity of the air stream while the other element shall compensate for changes in temperature. Each thermal flow sensor and its associated control circuit and signal conditioning circuit shall be factory calibrated and be interchangeable to allow replacement of a sensor without recalibration of the entire flow station. The sensor in the array shall be located at the center of equal area segment of the duct and the number of sensors shall be adequate to accommodate the expected velocity profile and variation in flow and temperature. The airflow station shall be of the insertion type in which sensor support structures are inserted from the outside of the ducts to make up the complete electronic velocity array.
    - b. Thermal flow sensor shall be constructed of hermetically sealed thermistors or nickel chromium or reference grade platinum wire, wound over an epoxy, stainless steel or ceramic mandrel and coated with a material suitable for the conditions to be encountered. Each dual sensor shall be mounted in an extruded aluminum alloy strut.

2. Air Flow Sensor Grid Array:
  - a. Each sensor grid shall consist of a lattice network of temperature sensors and linear integral controllers (ICs) situated inside an aluminum casing suitable for mounting in a duct. Each sensor shall be mounted within a strut facing downstream of the airflow and located so that it is protected on the upstream side. All wiring shall be encased (out of the air stream) to protect against mechanical damage.
  - b. The casing shall be made of welded aluminum of sufficient strength to prevent structural bending and bowing. Steel or iron composite shall not be acceptable in the casing material.
  - c. Pressure drop through the flow station shall not exceed 4 Pascal (0.015" W.G.) at 1,000 meter per minute (3,000 FPM).
3. Electronics Panel:
  - a. Electronics Panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.
  - b. Electronics Panel shall be A/C powered 120 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems. The electronic panel shall have the capability to accept user defined scaling parameters for all output signals.
  - c. Electronics Panel shall have the capability to digitally display airflow in CFM and temperature in degrees F. The displays shall be provided as an integral part of the electronics panel. The electronic panel shall have the capability to totalize the output flow in CFM for two or more systems, as required. A single output signal may be provided which will equal the sum of the systems totalized. Output signals shall be provided for temperature and airflow. Provide remote mounted air flow or temperature displays where indicated on the plans.
  - d. Electronics Panel shall have the following:
    - 1) Minimum of 12-bit A/D conversion.
    - 2) Field adjustable digital primary output offset and gain.
    - 3) Airflow analog output scaling of 100 to 10,000 FPM.
    - 4) Temperature analog output scaling from -45°C to 70°C (-50°F to 160°F).
    - 5) Analog output resolution (full scale output) of 0.025%.
  - e. All readings shall be in I.P. units.
4. Thermal flow sensors and its electronics shall be installed as per manufacturer's instructions. The probe sensor density shall be as follows:

Probe Sensor Density	
Area (sq.ft.)	Qty. Sensors
<=1	2
>1 to <4	4
4 to <8	6

8 to <12	8
12 to <16	12
>=16	16

- a. Complete installation shall not exhibit more than  $\pm 2.0\%$  error in airflow measurement output for variations in the angle of flow of up to 10 percent in any direction from its calibrated orientation. Repeatability of readings shall be within  $\pm 0.25\%$ .
- C. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:
1. Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
  2. For systems with multiple major trunk supply ducts, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the controller.
  3. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
  4. In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually-reset.
- D. Constant Volume Control Systems shall consist of an air flow measuring station along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its air flow signal and static pressure signal from the flow measuring station and shall have a span not exceeding three times the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 2 Pascal (0.008 inch) velocity pressure as measured by the flow station.
- E. Airflow Synchronization:
1. Systems shall consist of an air flow measuring station for each supply and return duct, the CU and such relays, as required to provide a complete functional system that will maintain a constant flow rate

difference between supply and return air to an accuracy of  $\pm 10\%$ . In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representation of total flow.

2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

#### **A. General:**

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
2. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
3. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
4. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
7. Install equipment level and plum.

#### **B. Electrical Wiring Installation:**

1. All wiring and cabling concealed / non-accessible and / or subject to damage shall be installed in conduits. Plenum-rated cable is acceptable provided it is installed in a neat, workmanlike fashion and properly supported at intervals of no less than 10 feet. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling: these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 21. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, Communications Horizontal Cabling.

3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
4. 120 Volt normal, emergency and UPS back up power as required for operation is furnished and installed to DDC controllers under another section of this specification. This contractor is responsible to provide written coordination of the necessary locations for this scope.
5. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
6. Install all system components in accordance with local Building Code and National Electric Code.
  - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
  - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
  - c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
  - d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
7. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
8. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
9. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.

C. Install Sensors and Controls:

1. Temperature Sensors:
  - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
  - b. Calibrate sensors to accuracy specified, if not factory calibrated.

- c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
  - d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
  - e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors from contact with metal casings and coils using insulated standoffs.
  - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
  - g. All pipe mounted temperature sensors shall be installed in wells.
  - h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
  - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
2. Pressure Sensors:
- a. Install duct static pressure sensor tips facing directly downstream of airflow.
  - b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
  - c. Install snubbers and isolation valves on steam pressure sensing devices.
3. Actuators:
- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
  - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
  - c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
4. Flow Switches:
- a. Install flow switch according to manufacturer's written instructions.
  - b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.



D. Installation of network:

1. Ethernet:

- a. The network provided by the VA shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
  - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 100 Base TX (Category 5e cabling) for the communications between the ECC and the B-BC and the B-AAC controllers.
2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.

E. Installation of digital controllers and programming:

1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

### 3.2 SYSTEM VALIDATION AND DEMONSTRATION

- A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the contractor is to perform a complete validation of all aspects of the controls and instrumentation system.

B. Validation

1. Prepare and submit for approval a validation test plan including test procedures for the performance verification tests. Test Plan shall address all specified functions of the ECC and all specified sequences of operation. Explain in detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a test check list to be used by the Installer's

agent to check and initial that each test has been successfully completed. Deliver test plan documentation for the performance verification tests to the owner's representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.

2. After approval of the validation test plan, installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. Demonstration

1. System operation and calibration to be demonstrated by the installer in the presence of the Architect or VA's representative on random samples of equipment as dictated by the Architect or VA's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the VA.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
4. The following witnessed demonstrations of field control equipment shall be included:
  - a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
  - b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
  - c. Demonstrate the software ability to edit the control program off-line.
  - d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.
  - e. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
  - f. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
  - g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
  - h. Prepare and deliver to the VA graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.
  - i. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop

trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.

5. Witnessed demonstration of ECC functions shall consist of:
  - a. Running each specified report.
  - b. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
  - c. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
  - d. Execute digital and analog commands in graphic mode.
  - e. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
  - f. Demonstrate EMS performance via trend logs and command trace.
  - g. Demonstrate scan, update, and alarm responsiveness.
  - h. Demonstrate spreadsheet/curve plot software, and its integration with database.
  - i. Demonstrate on-line user guide, and help function and mail facility.
  - j. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.
  - k. Demonstrate multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
  - l. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 23 10 00**

**FACILITY FUEL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. Diesel fuel oil tanks, pumps, piping, and accessories located outside, underground or aboveground as shown on contract drawings. Refer to contract drawings for type of fuel, for tank capacities, pump schedules, tank configuration and tank appurtenances including tank access platform, hand rails and access platform ladder.
- B. Tank fluid level monitoring and alarm systems.
- C. Leak detection system for tanks and underground piping.
- D. Fuel oil quality maintenance system (water and particulate removal).

**1.2 RELATED WORK:**

- A. Excavation and backfill for underground piping: Section 31 20 00, EARTH MOVING and Section 31 20 11, EARTH MOVING (SHORT FORM) .
- B. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- C. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- D. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- E. Concrete ballast foundations and concrete pads: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- F. Platforms, stairs, ladders and railings for aboveground tanks: Section 05 50 00, METAL FABRICATIONS.
- G. Sealing of pipe penetrations: Section 07 92 00, JOINT SEALANTS.
- H. Primer and finish painting: Section 09 91 00, PAINTING.
- I. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- J. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- K. Fuel oil pumps for engine generators and day tanks: Section 26 32 13, ENGINE GENERATORS.

- L. Underground conduit systems for tank fluid level monitors and tank and piping leak detectors: Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

### **1.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Mechanical equipment and components are to be seismically qualified/certified per ASCE 7-05, Chapter 13, and as clarified in the Office of Statewide Health Planning and Development (OSHDP) Code Application Notice (CAN) No. 2-1708A.5.
- B. Seismic Performance: Active equipment shall be special seismic certified utilizing shake table testing in accordance with ASCE 7-05, Section 13.2.5, using criteria applicable to IBC Seismic Design Category F. The unit supplied for installation in this Project shall not have been subjected to shake table testing. Testing shall be conducted at nationally recognized test laboratory acceptable to the VA. No alternate method of proving compliance will be accepted for this Project. Components with hazardous components shall be certified by supplier as maintaining containment following the design earthquake analysis or by shake table testing as described above.
- C. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS for additional seismic performance criteria.

### **1.4 QUALITY ASSURANCE:**

- A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers, and will be based on Contractor's certification that:
  - 1. Manufacturers regularly and currently manufacture tanks, tank and piping accessories, tank fluid level monitoring and leak detection systems, fuel quality management systems.
  - 2. Manufacturers of steel tanks participate in the Quality Assurance Program of the Steel Tank Institute (STI).
  - 3. The design and size of each item of equipment provided for this project is of current production and has been in satisfactory operation on at least three installations for approximately three years. Current models of fluid level and leak detection systems with less than three years service experience are acceptable if similar previous models from the same manufacturer have at least three years service experience.
- B. Apply and install materials, equipment and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR) for resolution. Provide copies of installation instructions to the RE/COTR two weeks prior to commencing installation of any item.

- C. All equipment shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components or overall assembly.
- D. Tanks, Secondary Containment Systems for Piping, Plastic Piping and Containment Systems, Tank Level Monitoring Systems, Leak Detection Systems, Fuel Quality Management Systems, Cathodic Protection Systems: Authorized manufacturers representatives shall provide on-site training of installers and supervision of the installation and testing of the equipment and systems to assure conformance to written instructions of manufacturers.
- E. Tank and piping installation contractor shall be certified as acceptable by local and state pollution control authorities.
- F. Entire installation shall conform to requirements of local and state pollution control authorities.
- G. Pipe Welding: Conform to requirements of ASME B31.1. Welders shall show evidence of qualification. Welders shall utilize a stamp to identify their work. Unqualified personnel will be rejected.
- H. Assembly of Glass Fiber Reinforced Plastic Piping: Installation personnel shall have been trained, tested and certified under a procedure approved by the manufacturer of the piping. Proof of certification, in writing, shall be provided to the RE/COTR.
- I. Where specified codes or standards conflict, consult the RE/COTR.
- J. Label of Conformance (definition): Labels of accredited testing laboratories showing conformance to the standards specified.
- K. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a safe, complete and fully operational system which conforms to contract requirements and in which no item is subject to conditions beyond its design capabilities.
- L. Tank accessories shall include access platform, access ladder, and hand rails. These accessories shall fully comply with California OSHA requirements.

**1.5 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

C. Aboveground Steel Tanks, Including Vault-type Tanks:

1. Drawings of tanks, supports, ladders, platforms, tank manholes, emergency relief vents and all accessories. Include overall dimensions and dimensional locations and sizes of pipe connections, and access openings.
2. Recommended tank support locations.
3. Weight of entire tank assembly, empty and flooded.
4. Design and construction of primary tanks, insulation, secondary containment, supports, pipe connections, platforms.
5. Application and performance data on coatings from manufacturer of coatings.
6. Data certifying tanks are designed for surcharge loads of platforms shown.
7. Certification of compliance with specified standards.
8. Certification that steel tank manufacturer participates in Steel Tank Institute (STI) Quality Assurance Program.
9. Design, construction, performance, dimensions of emergency relief vents.
10. Seismic Data: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Fuel Piping and Pumps:

1. ASTM and UL compliance.
2. Grade, class or type, schedule number.
3. Manufacturer.

E. Pipe Fittings, Unions, Flanges:

1. ASTM and UL compliance.
2. ASTM standards number.
3. Catalog cuts.
4. Pressure and temperature rating.

F. Foot Valves, Check Valves, Overfill Prevention Valves:

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Pressure loss and flow rate data.
4. Materials of construction.
5. Accessories.



- G. Secondary Containment System for Fuel Piping:
  - 1. Sizes, materials, construction of containment system including end seals, sumps, coatings and pipe supports.
  - 2. Layout of system.
  - 3. Installation instructions.
  - 4. Design of cathodic protection system (steel casing).
- H. Leak Detection System:
  - 1. Drawings, description and performance data on sensors, control units.
  - 2. Description of operation.
  - 3. Layout of system.
  - 4. Installation and operating instructions.
  - 5. Data on interconnecting wiring systems to be furnished.
- I. Tank Fluid Level Monitoring Instrumentation System:
  - 1. Drawings showing instruments and in-tank sensing units, with dimensions.
  - 2. Design and construction of all elements of system.
  - 3. Installation instructions.
- J. Tank and Piping Accessories: Design, construction, and dimensions of vent caps, fill boxes, fill caps, spill containers, hand rails, access platform, access ladder, and other accessories.
- K. Fuel Quality Maintenance System:
  - 1. Drawings and description of all components and arrangement of system.
  - 2. Design and performance of pumps, filters.
  - 3. Catalog data and operation of control system.
  - 4. Installation instructions.
- L. Seismic Qualification: Submit proof of equipment qualification to requirements for Special Seismic Certification. See Seismic Performance Requirements article.
  - 1. Proof of qualification shall consist of certificate issued by testing laboratory, signed by both laboratory representative and equipment manufacturer.
  - 2. Alternate proof of qualification: OSHPD pre-approved equipment with OSHPD OPA number.

#### **1.6 DELIVERY, STORAGE AND HANDLING:**

- A. Protection of Equipment:
  - 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the

Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the RE/COTR. Such repair or replacement shall be at no additional cost to the Government.
3. Protect new equipment and piping systems against entry of foreign matter on the inside. Clean both inside and outside before painting or placing equipment in operation.

B. Cleanliness of Equipment and Piping:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to provide clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Contractor shall be fully responsible for all costs, damages and delay arising from failure to provide clean systems and equipment.

**1.7 APPLICABLE PUBLICATIONS:**

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

B. Federal Specifications (Fed. Spec.):

1. A-A-60005 Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole

C. ASTM International (ASTM):

1. A36/A36M-05 Carbon Structural Steel
2. A53/A53M-10 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. A105/A105M-12 Carbon Steel Forgings for Piping Applications
4. A106/A106M-10 Seamless Carbon Steel Pipe for High Temperature Service
5. A126-04 (R2009) Gray Iron Castings for Valves, Flanges and Pipe Fittings
6. A234/A234M-10 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
7. B62-09 Composition Bronze or Ounce Metal Castings
8. D2996-01 (2007) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe

- D. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- E. American Society of Mechanical Engineers (ASME):
  - 1. B16.5-09 Pipe Flanges and Flanged Fittings (NPS 1/2-24).
  - 2. B16.9-07 Factory-Made Wrought Buttwelding Fittings
  - 3. B16.11-09 Forged Fittings, Socket-Welding and Threaded
  - 4. B31.1-10 Code for Pressure Piping, Power Piping with Current Amendments
- F. National Electrical Manufacturers Association (NEMA):
  - 1. 250-08 Enclosures for Electrical Equipment (1000 Volts Maximum)
- G. National Fire Protection Association (NFPA):
  - 1. 30-08 Flammable and Combustible Liquids Code
  - 2. 31-06 Installation of Oil Burning Equipment
  - 3. 70-08 National Electrical Code
- H. Underwriters Laboratories Inc. (UL):
  - 1. 142-10 Steel Aboveground Tanks for Flammable and Combustible Liquids
  - 2. 971-06 Non-Metallic Underground Piping for Flammable Liquids
  - 3. 2085-10 Protected Above-ground Tanks for Flammable and Combustible Liquids
- I. NACE International (Corrosion Engineers) (NACE):
  - 1. SP0169-07 Control of External Corrosion on Underground or Submerged Metallic Piping Systems
  - 2. NACE 3/SSPC-SP6-07 Commercial Blast Cleaning
  - 3. NACE 4/SSPC-SP7-07 Brush-off Blast Cleaning
- J. American Petroleum Institute (API):
  - 1. 1631-01 Interior Lining and Periodic Inspection of Underground Storage Tanks

#### **1.8 PERMITS:**

- A. Contractor shall obtain and complete all tank permit and registration forms required by governmental authorities.

## **PART 2 - PRODUCTS**

### **2.1 ABOVEGROUND STEEL TANKS:**

- A. Type: Factory fabricated all welded steel, horizontal cylindrical or rectangular configuration, atmospheric pressure, internal and external corrosion protection as specified. In addition to specified requirements, tanks shall be fabricated in accordance with Steel Tank Institute (STI) design standards by manufacturer that participates in STI Quality Assurance Program.
- B. Construction:
  - 1. ASTM A36 steel, conform to UL 142. Inner and outer tanks of double wall tanks shall both conform. Provide label of conformance.
  - 2. Conform to NFPA 30 or 31 as applicable.
  - 3. Double-wall, insulation between walls, conforming to STI F941 "Fireguard" construction, and to UL 2085. Provide label of conformance.
  - 4. Single-wall. No STI standards apply.
  - 5. Interstitial space between tank walls shall provide minimum containment of 110 percent of primary tank contents.
  - 6. Design for surcharge load produced by tank-mounted platforms and platform loadings shown. Design tanks for saddle supports furnished by tank manufacturer.
  - 7. Leaks and abrasions are not permitted. Maximum permissible out-of-roundness of cylindrical shells is one percent of the diameter.
  - 8. Provide lifting lugs for rigging tanks.
  - 9. Make provisions for leak detectors to be installed at lowest part of interstitial space between walls of double-wall tanks.
- C. Platforms, Stairs, Ladders and Handrails: Provide welded steel assemblies as shown, conforming to OSHA requirements. Provide welded steel tank attachments designed to support platform framing, stairs, ladders and live and dead loadings. Clean and coat all surfaces as specified for tank and steel dike exterior. Galvanizing is an acceptable alternative.
- D. Factory Cleaning: Clean interior and exterior of tanks and steel dikes (if furnished). Remove mill scale, dirt, rust, oil, welding debris, loose coatings and coatings incompatible with fuel stored or protective coating. Sandblast exterior in accordance with NACE 3.
- E. Factory Coating: Provide tanks and steel dikes (if furnished) with exterior coat of rust-resistant metal primer, specified under Section 09 91 00, PAINTING. Coat interior from bottom of tank to 1 m (3 feet) above bottom in compliance with API RP1631.
- F. Field Painting: Clean and coat all surfaces as specified in Section 09 91 00, PAINTING.

G. Pipe Connections to Tanks:

1. Conform to UL 142.
2. Pipe sizes 50 mm (2 inches) and smaller, threaded. Pipe sizes 65 mm (2 1/2 inches) and larger, flanged, 1025 kPa (150 pound) ASME rating.
3. Welded joints required on steel piping located inside tanks.
4. Provide and coordinate tank connection quantities, sizes and types with requirements of tank level gage unit; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.
5. On double-wall tanks, provide valved drain of interstitial space.

H. Tank Manholes: Provide quantity shown. Bolted cover type, gasketed.

I. Internal Ladder: Provide as shown with 50 mm x 6 mm (2 inch x 0.25 inch) sides and 20 mm (0.75 inch) diameter rungs at 300 mm (12 inches) on center. Provide slide supports to allow for tank movement.

J. Wear (Striker) Plates: Provide 300 mm (12 inch) square, 6 mm (0.25 inch) thick steel plates welded to tank bottom directly under the sounding opening, the fuel return discharge, and the fill discharge.

K. Lifting Lugs: Provide for rigging tanks.

L. Emergency Relief Vents for Fire Exposure: Venting capacity shall conform to NFPA 30 or 31 as applicable. Standard product of a manufacturer, designed to automatically open at tank pressure of 17 kPa (2.5 psi) gage. Spring-loaded lid, aluminum or cast iron construction with Teflon seating surface. Provide separate vents for primary and secondary tanks.

M. Provide fittings for grounding per NFPA 70.

N. Seismic Design: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**2.2 ABOVEGROUND CONCRETE-INSULATED STEEL VAULT TANKS:**

A. Type: All-welded steel tank, horizontal cylindrical or rectangular configuration, atmospheric pressure, concrete insulation, double-containment, ballistics and impact tested for aboveground installation as shown. Entire unit factory-fabricated, including steel tank and concrete insulation. Provide tank supports that can be anchored to a concrete foundation.

B. Construction:

1. Comply with UL-2085 for protected tanks, vehicle impact resistant and projectile resistant with secondary containment. Provide label of conformance.
2. Inner tank ASTM A36 steel constructed in conformance with UL-142. Provide label of conformance. Steel tanks shall be supported as recommended by steel tank manufacturer. Top of secondary tank shall be sloped to shed rainwater. Test tanks for leaks with test pressure

- of 20 - 34 kPa (3 - 5 psi) gage. Furnish certificate that inner and outer tanks have been tested and are leak-free and pressure-tight.
3. Concrete Insulation:
    - a. Shall consist of 25 mPa (3000 psi) minimum concrete.
    - b. Shall be structurally designed to support the filled tank and a top live load of 4.8 kPa (100 lb./sq. ft.).
    - c. Monolithic pour with no cold joints, heat sinks. As an alternate, there may be one continuous shiplap joint located at horizontal center of vault sealed with fire and fuel resistant gaskets.
    - d. Construct in accordance with ACI and AASHTO standards including concrete placement, vibration, and quality assurance.
  4. Conform to NFPA 30 or 31 fire safety standards as applicable. Design for two-hour fire exposure. Provide fittings for grounding per NFPA 70.
  5. The tank assembly shall have capability of physical monitoring for leaks between primary and secondary containment.
  6. Provide overfill containment (spill container) with internal drain and positive seal.
- C. Factory Cleaning: Clean interior and exterior. Remove mill scale, dirt, rust, oil, welding debris, loose coatings and coatings incompatible with fuel stored or protective coating.
- D. Factory Coatings: Provide coating of rust resistant red oxide primer on non-fuel side of steel tanks. For tanks with interior access, coat interior of primary tank from bottom to 1 m (3 feet) above bottom in conformance with API RP 1631. Provide two coats of fuel resistant epoxy coating on exposed surfaces of the external concrete tank.
- E. Platforms, Ladders, Stairs, and Handrails: Provide as shown. Shall be welded steel assemblies conforming to OSHA requirements. Paint in accordance with Section 09 91 00, PAINTING. Galvanizing is an acceptable alternative.
- F. Pipe Connections to Tanks:
  1. Pipe shall terminate 75 mm (3 inches) minimum from top of unit.
  2. Conform to UL 142.
  3. Pipe sizes 50 mm (2 inches) and smaller, threaded. Pipe sizes 65 mm (2 1/2 inches) and larger, 1025 kPa (150 pound) ASME flanged.
  4. Welded joints required on steel piping located inside tanks.
  5. Provide and coordinate tank connection quantities, sizes and types with requirements of tank level gage unit; leak detector sensor; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.
  6. Provide valved drain on interstitial space.
- G. Tank Manholes: Provide quantity and size shown. Bolted cover type, gasketed.

- H. Emergency Relief Vents for Fire Exposure: Venting capacity shall conform to NFPA 30 or 31 as applicable. Provide separate vents for primary and secondary tanks. Standard product of a manufacturer, designed to automatically open at tank pressure of 17 kPa (2.5 psi). Spring-loaded lid, aluminum or cast iron construction, with Teflon-coated seating surface.
- I. Internal Ladder: Provide as shown with 50 mm x 6 mm (2 inch x 0.25 inch) sides and 20 mm (0.75 inch) diameter rungs at 300 mm (12 inches) on center. Provide slide supports to allow for tank movement.
- J. Wear (Striker) Plates: Provide 300 mm (12 inch) square, 6 mm (0.25 inch) thick steel plates welded to tank bottom directly under the sounding opening, the fuel return discharge, and the fill discharge.
- K. Lifting Lugs: Provide for rigging tanks.
- L. Seismic Design: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **2.3 TANK AND PIPING ACCESSORIES:**

- A. Vent Caps: Galvanized cast iron or cast aluminum with brass or bronze screens, arranged to permit full venting and to prevent entry of foreign material into the vent line. Same pipe size as vent pipe.
- B. Fill Boxes:
  - 1. Fill cap shall be lockable, tight-fill design with provision for padlock on the top of the cap. Fill cap shall screw onto threaded adapter that can be removed without removing fill box. Entire assembly shall seal tight with no leakage during filling and when cap is in place.
  - 2. Provide special tools necessary for opening fill boxes and fill caps.
- C. Fill caps located above grade without fill boxes shall be lockable, tight-fill design, operated by special wrench that shall be furnished. Entire assembly shall seal tight with no leakage during fill and when cap is in place.
- D. Refer to Section 05 50 00, METAL FABRICATIONS, for access platforms shown for aboveground tanks.
- E. Support horizontal portion of pipes located inside tank every 2100 mm (7 feet) maximum.
- F. Furnish gauging chart, liters versus mm and gallons versus inches depth.
- G. Furnish sounding rod for each tank size. Mark rods in increments representing five percent of tank capacity. Provide length of rod suitable for tank burial depth (if applicable). Rods shall be graduated in gallons.
- H. Fill Point Identification:
  - 1. Fill Caps above Grade: Aluminum, brass or bronze plate, clamped to fill pipe, with stamped or engraved letters 18 mm (0.75 inch) high.

2. Legend: "DIESEL FUEL FILL" as appropriate.

#### **2.4 PIPING, VALVES, FITTINGS:**

- A. Fuel supply and return, tank fill, vents, sounding, pump out, steam and condensate. Contractor may choose piping materials from those listed below.
- B. Steel Pipe and Fittings:
  1. Piping: Steel, seamless or electric resistance welded (ERW), ASTM A53 Grade B or ASTM A106 Grade B, Schedule 40. Aboveground piping shall be painted. Refer to Section 09 91 00, PAINTING.
  2. Joints: Socket or butt-welded. Threaded joints not permitted except at valves, unions and tank connections.
  3. Fittings:
    - a. Butt-welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
    - b. Socket-welded joints: Forged steel, ASME B16.11, 13 700 kPa (2000 psi) class.
  4. Unions: Malleable iron, 2050 kPa (300 psi) class.
  5. Companion flanges: Flanges and bolting, ASME B16.5.
  6. Welding flanges: Weld neck, ASME B16.5, forged steel ASTM A105, 1025 kPa (150 psi).
- C. Glass Fiber Reinforced Plastic (FRP) Pipe and Fittings:
  1. Conform to UL 971 and ASTM D2996 using a filament-winding process and epoxy or vinyl ester resins.
  2. Design pipe, fittings and joining system for required fuel service, 66 °C (150 °F), 1030 kPa (150 psi) pressure, 68 kPa (20 inches HG) vacuum.
  3. Provide an integral resin-rich liner, 0.5 mm (0.020 inches) minimum thickness to enhance the corrosion resistance. Outer layer shall include ultra-violet inhibitors. Joining adhesive shall be designed for the pipe furnished and shall be supplied by the pipe manufacturer.
  4. Plastic pipe and fittings are not permitted on steam or condensate service. Plastic piping allowed in underground use only.
- D. Check Valves - Fuel Pump Suction.
  1. Pipe Sizes 50 mm (2 inches) and under: Rated for 1375 kPa (200 psi) water-oil-gas, swing-type, threaded ends, ASTM B62 bronze body. Provide union adjacent to valve.
  2. Pipe Sizes 65 mm (2 1/2 inches) and above: Rated for 1375 kPa (200 psi) water-oil-gas, swing-type, 850 kPa (125 pounds) ASME flanged ends, ASTM A126 class B cast iron body.
- E. Foot Valves - Fuel Pump Suction: Double poppet, lapped-in metal-to-metal seats, double-guided stems, 20 mesh inlet screen, same size as fuel suction piping. Foot valve shall be removable to above grade through the tank manhole enclosure or through extractor fitting.



- F. Extractor Fittings: Arranged to permit removal of foot valves, overfill prevention valves, and other devices that are located below grade. Access point shall be through a cast iron fill box-type manhole located at grade. Provide extractor wrench.
- G. Overfill Prevention Valve: Aluminum automatic valve designed for aboveground tanks. Locate valve near the top of the tank in the fill pipe. On aboveground tanks, or tanks pressure-filled, provide single stage valve, rated for fill flow and pressure, which stops flow completely at 95 percent of tank capacity. Valve shall include method for draining oil trapped above the valve into the tank.
- H. Flexible Connections: Annular corrugated stainless steel close-pitch hose with stainless steel over braid, designed and listed for use in handling diesel fuel oil.

## **2.5 SECONDARY CONTAINMENT FOR UNDERGROUND FUEL PIPING SYSTEMS:**

- A. Enclose the fuel supply, return and fill pipes in factory-engineered and fabricated secondary containment conduit systems. The systems shall be complete with end seals, with 25 mm (1.0 inches) minimum continuous annular space, 37 mm (1.5 inches) between carrier pipes, which shall contain all leakage and which has provisions for leak detection system as specified. Contractor may choose containment conduit materials from those listed below.
- B. Steel Conduit with Fusion-Bonded Epoxy Coating and Cathodic Protection:
  - 1. Galvanized carbon steel pipe, ASTM A53, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up through 650 mm (26 inches). All welded construction.
  - 2. Sand blast exterior per NACE 3.
  - 3. Coat exterior with 0.5 mm (20 mils) thick fusion-bonded epoxy.
  - 4. Provide cathodic protection designed by corrosion specialist and consisting of galvanic anodes, test stations, interconnecting wiring in conformance with UL 1746 and NACE SP-0169. Electrical isolation required between all connecting systems in manholes and buildings.
- C. Steel Conduit with Fiberglass Reinforced Plastic (FRP) Coating:
  - 1. Carbon steel pipe, ASTM A53, Grade B, Schedule 40 for diameters through 125 mm (5 inches), 3.4 mm (0.134 inch) thick for diameters greater than 125 mm (5 inches) up thru 650 mm (26 inches). All welded construction.
  - 2. Blast clean exterior per NACE 4.
  - 3. Apply fiberglass reinforced polyester (FRP) external cladding at least 2.5 mm (0.10 inches) thick with ultra-violet inhibitor. Cladding on field joints shall be equivalent to factory-applied cladding applied on remainder of system.
  - 4. Test entire system for holidays using a 35,000 volt holiday detector.

5. This system not permitted when carrier pipe or tracing system contains steam or condensate.
- D. Glass Fiber Reinforced Plastic (FRP) Conduit:
1. Conform to UL 971 and ASTM D2996 using a filament-winding process and epoxy or vinyl ester resins.
  2. Design pipe, fittings and joining system for carrier pipe fuel service, 66 deg C 150 deg F) 1030 kPa (150 psi) pressure, 68 kPa (20 inches Hg) vacuum.
  3. Provide an integral resin-rich liner, minimum thickness 0.25 mm (0.010 inch). Outer layer shall include ultra-violet inhibitors.
  4. Minimum total wall thickness 1.8 mm (0.07 inch) for diameters below 200 mm (8 inches), 2.8 mm (0.11 inch) for diameters 200 mm (8 inches) and 250 mm (10 inches), 5 mm (0.20 inch) for diameters 250 mm (10 inches) through 500 mm (20 inches), and 6 mm (0.25 inch) for diameters above 500 mm (20 inches).
  5. This conduit system is not permitted when carrier pipe or tracing system contains steam or condensate.
- E. Pipe Supports: Provide supports within conduit for fuel carrier pipes spaced 2100 mm (7 feet) apart except 3000 mm (10 feet) apart for carrier pipe size 50 mm (2 inches) through 100 mm (4 inches). Support design shall permit differential movement of pipes, allow drainage of leakage to sumps, and maintain alignment of carrier pipes.
- F. Conduit End Seals: Same material and coating as conduit; leak tight.
- G. Leak Detector Sensor Locations: On each piping system, provide sumps at the low points with water-tight openings above grade for access to leak detector sensors. Design sumps to intercept all potential leakage. Maximum spacing between sumps, 3000 mm (100 feet).

## **2.6 LEAK DETECTION SYSTEMS:**

- A. Automatic digital continuous monitoring systems responsive to the presence of water and hydrocarbons in the interstitial space of the double-wall tanks, in the tank manhole access enclosures, and in the secondary containment of fuel piping systems. System shall distinguish between hydrocarbon and water and identify location of leak as to individual tank and piping system. System may be combined with tank fluid level monitor and alarm system specified in Article, TANK FLUID LEVEL MONITOR AND ALARM SYSTEM.
- B. Functions and Arrangement:
1. Single control station to monitor all sensing probes.
  2. Visual indicator to monitor and identify leaks as water or hydrocarbon and location.
  3. Indicators showing system status including faults and alarms.
  4. On board printer that provides complete reports of all system functions upon command.

5. Panel circuit test button.
6. 95 dB audible alarm with silencing control to sound when leak is detected.
7. Eight hour memory backup system with battery.
8. NEMA 250 Type 4 cabinet.
9. UL or other accredited testing laboratory listing.
10. RS232 Modbus communications with engineering control system to indicate system in service and alarm conditions.

C. Sensors:

1. Designed for required locations including: Insertion between walls of double-wall tanks, in sumps in double-wall piping systems and in tank manhole enclosures. Sensing points shall be at lowest point of each tank or sump. Intrinsically safe design.
2. Sensing units shall detect presence of water and a minimum 3 mm (0.125 inch) thick layer of hydrocarbon on surface of water and minimum 50 mm (2 inch) thickness of hydrocarbon in area that has no water present.
3. Sensors shall be arranged to allow replacement of individual sensors without disturbing other portions of leak detection system or fuel storage and piping system. Underground sensors shall be accessed through caps as grade.
4. Materials of construction shall be non-corroding.
5. Transmit status signal to control unit.

D. Components:

1. Provide manholes at grade for each sensor cap similar in construction to fill boxes. Manholes shall be cast iron, quick-opening cover, watertight, minimum size necessary to accommodate sensor caps. Provide identification plates, similar to those specified for fill points, labeled "MONITORING/OBSERVATION WELL-DO NOT FILL". Provide special tools if necessary for opening covers.
2. Sensor housings from tank and piping to grade shall be Schedule 40 PVC, or stainless steel.
3. Underground wiring between probes and control unit: Place in water-tight corrosion-resistant conduit system conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

**2.7 TANK FLUID LEVEL MONITOR AND ALARM SYSTEMS:**

- A. Digital systems for central monitoring of fuel and water levels in all fuel oil storage tanks in the project. High and low level visual and audible alarms. Volumetric tank-tightness testing. Complete with all transducing, transmitting, and receiving devices. On board printer to provide complete report of all system functions upon command. System may be combined with leak detection system specified in Article, LEAK DETECTION SYSTEMS.

B. Fluid Level Monitor:

1. Digital continuous readout, showing tank oil and water levels in gallons, smallest reading one gallon. Provide identification of product measured, measuring units, and the tank number.
2. Tank and fuel characteristics contained in preprogrammed non-volatile field-replaceable databases. Protected power supply.

C. High and Low Fluid Level Alarm System:

1. Automatic continuous on-line monitoring of all tanks.
2. Visual and audible indicators combined with fluid level monitor. Identify the tank that is in alarm condition.
3. Manual alarm test and silencing controls.
4. Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.

D. Locate all indicators, selector switches, alarms on face of wall-mounted NEMA 250, Type 4 panel.

E. Remote Alarm Annunciator:

1. Visual and audible high level alarms adjacent to tank fill box locations. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.
2. Alarm shall include flashing red light with 180 degree visibility for each tank and 95 dB horn or 100 mm (4 inch) diameter bell. Provide alarm silence control.
3. Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".

F. Modbus communication to engineering control system to indicate tank fluid level and alarm conditions. Telephone modem communication capability.

G. System Performance: Accuracy plus or minus 2.5 mm (0.01 inch) of fluid height in inventory mode and 0.25 mm (0.001 inch) in leak detection mode. Automatic compensation for fluid temperature changes. Volumetric tank tightness sensitivity of 0.4 lph (0.1 gph).

H. Sensors:

1. Provide sensor types such as magnetostrictive, capacitance, float, hydrostatic and other types as necessary for the applications.
2. Apply in accordance with manufacturer's instructions with provisions for easy future replacement without need for excavation.
3. Provide for each hydrostatic sensor a constant flow differential pressure regulator and pneumatic transmitter protected from fuel contamination. Air supply shall include filter and over-pressure protection. Provide desiccant-type dryer on air supply designed for removal of water vapor. Dryer rating, minimum 280 cubic liters per minute (10 scfm). Provide moisture indicator. Dryer may be deleted if air supply source has a refrigerated dryer.

4. Float-type units shall be designed for installation and removal through a 100 mm (4 inch) diameter vertical pipe mounted in the top of the tank.

- I. Underground Wiring and Piping: Enclose in water-tight corrosion-resistant conduit system sized and arranged as recommended by system manufacturer and conforming to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.
- J. Code Conformance: NFPA-70.

## **2.8 FUEL OIL QUALITY MAINTENANCE SYSTEMS:**

- A. Complete factory-assembled automatic particulate filtration and dewatering system to maintain the purity of No. 2 fuel oil in storage. The system shall circulate the oil from the storage tank, through the system, and back to the storage tank. Provide quantity and capacity of systems to serve tanks as shown. Drawings may show multiple tanks served by one system. Smaller systems without large water storage tanks and without fuel additive injection shall be wall-mounted. Units with water storage tanks and/or additive injection shall be floor-mounted on steel skids on concrete foundations. Digital controls.
- B. Performance: Design for nearly 100 percent water removal. Provide 2 micron particulate filtration. Each system shall have capacity to turnover the largest connected full tank one time within 22 hours maximum. System shall be designed to allow continuous operation with brief interruptions to manually change filters and clean strainers.
- C. Components:
  1. Strainer: 100 mesh perforated stainless steel basket. Clamped covers. 860 kPa (125 psi) design pressure.
  2. Water Separation Unit: Two stage, designed to reduce water content of fuel to less than 10 ppm. Centrifugal separator for removal of large droplets and renewable resin-impregnated cellulose water coalescing elements. Water removed shall flow to water holding sump in the unit. Water sensing probe to alert the operator when water level in bowl has reached capacity.
  3. Filter: 2 micron filtration with 96% removal efficiency, valved manual drain. Replaceable elements.
  4. Filtration Pump: Positive displacement base-mounted pump with cast iron or bronze housing, for circulating the oil from the storage tank, through the water separation and filter units and back to the storage tank. Pump shall have carbon bushings, stainless steel shaft and Teflon mechanical seal, ODP motor.
  5. Controls:
    - a. Digital PLC electronic controls for all system control and alarm functions. Relay logic not acceptable.
    - b. Control panel with selector for modes of operation, indicators to show system status, and visual and audible alarms to signal the need for operator intervention. Operator interface shall be 2 x 20 LCD and keypad.

- c. Controls shall include:
    - 1) Control power "on-off".
    - 2) "Cycle Start".
    - 3) "Cycle Cancel".
    - 4) "Hand-off-Auto" for filtration pump.
    - 5) Pump cycle timer set function.
    - 6) Cycle duration selector.
  - d. Indications shall include:
    - 1) "Control Power On".
    - 2) "Pump Run".
    - 3) "Pump Failure".
    - 4) "Excess Water In Fuel".
    - 5) "Filter Water Level High".
    - 6) "Rupture Basin Leak" alarm.
    - 7) "High Pressure Drop in Strainer" alarm.
    - 8) "High Pressure Drop in Filters" alarm.
    - 9) "High Pressure" alarm and automatic shut down.
    - 10) "High Water Level" in water storage tank.
  - e. Filter and strainer differential pressure gages, differential pressure switches and control. Provide indication when filters should be changed.
  - f. Over pressure switch and control to shut down pump if filter inlet pressure exceeds limits.
  - g. All primary wiring exiting the enclosure shall be encased in conduit.
  - h. Magnetic motor starters with overload protection.
  - i. Circuit breakers.
  - j. Control enclosure shall be NEMA 12, fully gasketed doors with 3 point lockable latching. Interior shall have white gloss finish; exterior shall be chemical-resistant gray enamel. All controls and indicating devices shall be mounted on front of enclosure and labeled with black phenolic labels with white lettering.
  - k. Modbus communication to engineering control system for alarms and system status.
- D. Enclosure - Wall Mounted Units: 14 gauge steel, NEMA 12/13 standards, continuously welded, framed cabinet. Provide doors for complete access to all equipment. Doors shall have a turned edge, piano hinges, three-point locking mechanisms. Corrosion-resistant prime and finish coatings on all interior and exterior surfaces.
- E. Water Drainage System: Sealed bowl (bottle) with high level alarm system. Water collected in filters shall drain to a sealed bowl that can be easily removed and emptied.

## **2.9 FUEL TRANSFER PUMPS:**

- A. Provide submersible fuel oil transfer pumps from main storage tanks to day tanks and from above ground day tanks (other than belly tanks below generators). Pumps shall be UL listed and designed for Class I, Group D hazardous atmospheres. Pump shall be compatible with diesel. Equip for mounting on exterior storage tank. Provide with line pressure port, vent port and siphon ports. Shall be adjustable to suit tank depth.
- B. Provide base mounted, light oil pump and motor assemblies for returning fuel from day tank to main storage tank unless shown with submersible type. Pump assembly shall be direct drive unit suitable for No. 2, No. 4 and diesel oil. Pump and motor shall be mounted on a structural steel channel base. Shafts shall be directly connected with a flexible coupling with all rotating parts protected by an OSHA guard. Pumps shall be bi-rotational, positive displacement, internal gear types with cast iron housings and BUNA-N self adjusting mechanical seals. Provide with over pressure relief valve.

## **2.10 CONCRETE FOUNDATIONS:**

- A. Concrete pads for aboveground tanks are specified under Section 03 30 00, CAST-IN-PLACE CONCRETE. Credit for overburden is allowed.

## **2.11 BURIED UTILITY WARNING TAPE:**

- A. Tape shall be 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1750 psi) lengthwise and 10 300 kPa (1500 psi) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION AND TESTING, ABOVEGROUND TANKS:**

- A. Conform to NFPA 30 or 31 as applicable.
- B. Support tanks on steel saddles welded to the tanks. Anchor to concrete foundations. Provide molded neoprene isolation pads between the steel supports and the concrete foundation.
- C. After tanks are installed, test steel tanks with air pressure of 20 kPa to 35 kPa (3 - 5 psi), using soapsuds to locate leaks. Repair leaks by chipping to bare metal and rewelding. Retest until all leaks are repaired. Repair all damaged areas of prime coat on tanks and steel dikes (if furnished). Test interstitial area between steel tank walls with air at pressure recommended by tank manufacturer. Tests shall be witnessed by the RE/COTR.

- D. Surface finish coating for tanks and steel dikes (if furnished) is specified under Section 09 91 00, PAINTING.
- E. Provide electrical grounding in accordance with NFPA 70.

**3.2 INSTALLATION AND TESTING, UNDERGROUND PIPING SYSTEMS:**

- A. Leak Detection System: Arrange fuel and tracing media (if required for heated oil) carrier piping, enclosed in secondary containment piping, to accommodate leak detection system. Slope piping down toward tanks and leak detectors at 25 mm in 10 m (1 inch in 40 feet).
  - 1. Provide new leak detection system where required.
  - 2. Extend existing leak detection system where required.
- B. Steel Fuel and Tracing Media Carrier Piping: All joints butt or socket welding. Threaded piping is not permitted. Piping ends shall be accurately cut, true, and beveled for welding.
- C. Glass Fiber Reinforced Plastic (FRP) Fuel Carrier Piping and Secondary Containment Piping: Install in accordance with printed instructions of pipe manufacturer. Installation personnel trained in accordance with Article, QUALITY ASSURANCE. Plastic piping not permitted in same secondary containment system with steam or condensate piping.
- D. Secondary Containment Piping:
  - 1. Provide sand bedding and backfill material for steel piping and pea gravel for FRP piping.
  - 2. Top of system 450 mm (18 inches) minimum below grade.
  - 3. Design and locate leak detector sumps to intercept all potential leakage. Maximum spacing along each system, 3000 mm (100 feet).
  - 4. Seal all building and manhole wall penetrations with watertight flexible link seal system.
  - 5. After placing system, prior to backfill, repair all damage, including coatings, as recommended in printed instructions of system manufacturer. Perform 10,000 volt holiday test on coated steel systems.
  - 6. On steel systems that do not have FRP cladding, install cathodic protection system.
- E. Leak Test: Test carrier pipes with air pressure at 690 kPa (100 psi), and test the containment piping with air pressure at 55 kPa (8 psi). Systems shall hold the pressure for 30 minutes. Repair all leaks and retest.
- F. Coatings for Steel Piping not in Secondary Containment System: Provide urethane coating and cathodic protection.
- G. Buried Utility Warning Tape: Install tape 300 mm (12 inches) below grade above the piping system.



**3.3 INSTALLATION, FILL BOXES AND ACCESS MANHOLES AT GRADE:**

- A. Provide for tank fill, tank sounding, leak detector sensors, and extractor fittings. Set at grade in concrete pads. Refer to fill box detail. Provide identification plate set into the concrete pad that identifies the purpose of the device and type of fuel in the tank.

**3.4 INSTALLATION AND TESTING, LEAK DETECTOR SYSTEMS FOR TANKS AND PIPING:**

- A. Wiring shall conform to NFPA-70.
- B. Locate control monitor panels 1500 mm (5 feet) above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Test operation of each probe, and monitoring system with fuel and water. If type of probe utilized is damaged by exposure to fuel, provide temporary probe for testing monitoring system.

**3.5 INSTALLATION, TANK FLUID LEVEL INDICATOR AND ALARM SYSTEM:**

- A. Wiring shall conform to NFPA-70.
- B. Locate level indicator and alarm panel 1500 mm (5 feet) above the floor on inside wall of boiler room, generator room or garage, depending on type of fuel tank served, unless shown otherwise.
- C. Locate remote high level alarm on exterior wall or pole in view of tank fill point, 2400 mm (8 feet) above grade.

**3.6 INSTALLATION, FUEL OIL QUALITY MAINTENANCE SYSTEMS:**

- A. Locate systems within easy reach of persons standing on floor, with sufficient elevation to allow gravity flow of water from system to water storage tank sitting on the floor.
- B. Connect to tank suction and return piping systems with isolation valves. Provide compound pressure gages at suction and discharge piping connections.

**3.7 INSTALLATION, CATHODIC PROTECTION TEST STATIONS:**

- A. Provide separate station for each tank and each piping system, anchor firmly, locate so that terminal board is 600 mm (2 feet) minimum above grade. Connect wiring from all anodes and protected structures to the test stations.

**3.8 TESTING, CATHODIC PROTECTION:**

- A. Testing performed by NACE-certified corrosion specialist; witnessed by RE/COTR.
- B. Test Instruments:
  - 1. Volt-Ammeter.

2. Saturated copper-copper sulfate reference electrode.
  3. Other instruments as required.
- C. Procedures: Conform to NACE NACE SP-0169.
- D. Test Results Required for Acceptance:
1. Potential of minus 0.85 volt between protected structure and reference electrode.
  2. Minimum shift of minus 300 millivolts upon application of protective current. Voltage measured between protected structure and reference electrode.
  3. Minimum shift of minus 100 millivolts upon interruption of protective current. Voltage measured between protected structure and reference electrode.
- E. Test Report: Provide complete report to RE/COTR showing all test measurements, calculations, list of instruments used.

### **3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 11 23**

**FACILITY NATURAL-GAS PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Medium pressure fuel gas systems for supply to fuel gas compressor and for duct burner and low pressure gas to water heater, including piping, equipment and all necessary accessories as designated in this section. High Pressure fuel gas piping for gas turbine generator downstream of gas compressor is included in Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 05 23, GENERAL DUTY VALVES FOR PLUMBING PIPING
- G. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION: Pipe Insulation.
- H. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: Fuel Gas Piping For Boiler Plants.
- I. Section 23 51 00 - BREECHINGS, CHIMEYS, and STACKS
- J. Section 23 09 23 - FACILITY MONITORING AND CONTROL SYSTEM: Gas flow meters.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pipe & Fittings.
  - 2. Valves.

3. Strainers.
4. All items listed in Part 2 - Products.

C. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### 1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
1. L-C-530 Coating, Pipe, Thermoplastic Resin
  2. L-T-1512 Tape Pressure Sensitive Adhesive Pipe Wrapping
- C. American National Standards Institute (ANSI):
- D. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
1. A13.1--96 (R2002) Scheme for Identification of Piping Systems
  2. B1.20.1-83 Pipe Threads, General Purpose, Inch
  3. B1.20.3-1976(R008) Dryseal Pipe Thread (Inch)
  4. B16.3-(2006) Malleable Iron Threaded Fittings: Classes 150 and 300 ANSI/ASME
  5. B16.5-09 Pipe Flanges and Flanged Fittings: NPS 1/2 through 24-Metric/Inch Standard
  6. B16.9-2007 Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME
  7. B16.11-2009 Forged Steel Fittings, Socket-Welding and Threaded ANSI/ASME
  8. B16.33-2007 Manually Operated Metallic Gas Valves for use in gas piping systems up to 125 psi (sizes NPS 1/2 thru NPS 2)
  9. B16.38-2007 Large Metallic Valves for Gas Distribution
  10. B31.8-2010 Gas Transmission and Distribution Piping Systems ANSI/ASME
  11. Z21.18-2007 Gas Appliance Regulations
  12. Z21.70-81 Earthquake Actuated Gas Shutoff Systems
  13. Z21.80-2011 Line Pressure Regulators

E. American Society for Testing and Materials (ASTM):

1. A47-99(2009) Standard Specification for Ferritic Malleable Iron Castings
2. A53-10 Standard Specification for Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless
3. A126-04(2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
4. A216-12 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High-Temperature Service
5. A536-09 Standard Specification for Ductile Iron Castings
6. A733-03(2009)e1 Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
7. B584-11 Standard Specifications for Copper Alloy Sand Castings for General Applications

F. National Fire Protection Association (NFPA):

1. 54-2009 National Fuel Gas Code

G. International Code Council

1. IPC 2009 International Plumbing Code
2. IFGC 2009 International Fuel Gas Code

H. International Association of Plumbing and Mechanical Officials (IAPMO):

1. Uniform Plumbing Code - 2009
2. IS6-06 Installation Standard

I. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

1. SP-78-2011 Cast Iron Plug Valves, Flanged and Threaded Ends
2. SP-110-2010 Ball Valve Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

**1.5 SYSTEM PRESSURE**

- A. Natural gas systems unless otherwise noted are designed and materials and equipment selected to prevent failure under gas pressure of kPa (50 psi downstream of utility meter/regulator).

**PART 2 - PRODUCTS**

**2.1 FUEL GAS SERVICE CONNECTIONS TO BUILDING**

- A. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building, use coated piping.

- B. Pipe: Black steel, ASTM A53, Schedule 40. Shop-applied pipe coating shall be one of the following types:
  - 1. Coal Tar Enamel Coating: Exterior of pipe and fittings shall be cleaned, primed with Type B primer and coated with hot-applied coal tar enamel with bonded layer of felt wrap in accordance with AWWA C203. Asbestos felt shall not be used; felt material shall be fibrous glass mat as specified in Appendix Section A2.1 of AWWA C203.
  - 2. Adhesive-thermoplastic Resin Coating: Fed. Spec. L-C-530, Type I
  - 3. Thermosetting Epoxy Coating: Fed. Spec. L-C-530, Type II
  - 4. Field-applied plastic tape material used on pipe joints and for repairing damaged areas of shop-applied coatings, Fed. Spec. L-T-1512, Type I, 10 mils nominal thickness for pipe joints, and Type II, 20 mils nominal thickness for coating repairs.
- C. Holiday Inspections: Procedure for holiday inspection: Holiday Inspection shall be conducted on all coatings to determine the presence and number of discontinuities in those coatings referenced in 2.6/B - 1, 2, 3, and 4 using a Tinker & Rasor model AP/W Holiday Detector. Holiday inspection shall be performed in a manner spelled out in the Tinker & Rasor operating instructions and at a voltage level recommended by the coating manufacturer or applicable NACE International Standard such as RPO 274-93 or RPO 490-90 in the case thermosetting epoxy coating. Holiday Detectors shall be calibrated and supplied with a certificate of calibration from the factory. A calibration of the Holiday Detector shall be performed once every 6 months to verify output voltages are true and correct.
- D. Fittings:
  - 1. Butt weld fittings, wrought steel, ANSI B16.9.
  - 2. Socket weld and threaded fittings forged steel, ANSI B16.11.
  - 3. Grooved End: Ductile iron (ASTM A536, Grade 65-45-12), malleable iron (ASTM A47, Grade 32510), or steel (ASTM A53, Type F or Type E or S, Grade B).
- E. Joints: Welded, ANSI B31.8.
- F. Earthquake Valve:
  - 1. Valve: Cast from aluminum, ANSI Z21.70.
  - 2. Valve actuator: Actuated by one stainless steel ball, incorporated with a bubble level, vertically mounted and have a single step manual reset level.
  - 3. Operating ambient temperature range: minus 40°C (minus 40°F) to 65.5°C (150°F)
  - 4. Maximum allowable pressure: 414 Kpa (60 psi).

## **2.2 FUEL GAS PIPING**

- A. Pipe: Black steel, ASTM A53, Schedule 40.
- B. Nipples: Steel, ASTM A733, Schedule 40.

C. Fittings:

1. Sizes 50 mm (2 inch) under ANSI B 16.3 threaded malleable iron.
2. Over 50 mm (2 inch) and up to 100 mm (4 inch) ANSI B16.11 socket welded.
3. Over 100 mm (4 inch) ANSI B16.9 butt welded.

D. Joints: Provide welded or threaded joints.

**2.3 EXPOSED FUEL GAS PIPING**

- A. Paint piping systems as specified in Section 09 91 00, PAINTING

**2.4 REGULATORS**

- A. Pilot Operated High Capacity Pressure Regulators: Comply with ANSI Z21.80.

1. Main Valve:

- a. Body and body flange: Cast iron, WCC Steel, CF8M stainless steel.
- b. Cage: CF8M stainless steel (Linear), 416 or 316 stainless steel , or hardened ENC coated cast iron (Quick Opening).
- c. Seat ring and valve plug: Hardened 416 stainless steel or 316 stainless steel.
- d. Travel indicator assembly: Steel or stainless steel except plastic for indicator scale.
- e. Piston ring: Polytetrafluoroethylene (PTFE) O-rings and soft parts: Nitrile (NBR) (standard), Fluorocarbon (FKM) or Ethylenepropylene (EPR).
- f. Spring: Steel or inconel.
- g. Bolting: Steel, stainless steel.

2. Actuator:

- a. Bonnet: Zinc-plated steel or 304 stainless steel.
- b. Diaphragm case: Steel or stainless steel.
- c. Bolting: Steel, stainless steel.
- d. Diaphragm plate: Cast iron, 316 or WCC stainless steel.
- e. Stem guide: Stainless steel
- f. Diaphragm and o-rings: Nitrile (NBR) (standard), Fluorocarbon (FKM), Ethylenepropylene (EPDM).
- g. Stem: 17-4 PH stainless steel (standard) or 316 stainless steel.

3. Pilot Mounting Parts:

- a. Tubing and connector fittings: Stainless steel.
- b. Pipe bushing: Malleable iron, stainless steel.
- c. Pipe nipples: Galvanized steel, stainless steel.

4. Pilot:

- a. Body, body plug, spring case, and closing cap: Stainless steel.
- b. Diaphragm: Nitrile (NBR), Fluorocarbon (FKM), or Ethylenepropylene (EPR).
- c. Limiter: Aluminum.

- d. O-rings and soft parts: Nitrile (NBR) or Fluorocarbon (FKM).
- 5. Maximum Inlet Pressure: 50 psig (345 kPa), designed to control to 25 psig downstream.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
  - 1. Body and Diaphragm Case: Carbon steel body (ASTM-A216, grade WCB); aluminum diaphragm case.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm: Nitrile.
  - 4. Seat: 316 stainless steel.
  - 5. Disk Assembly: 316 stainless steel/neoprene and 316 SS/nylon.
  - 6. Orifice: 316 stainless steel; interchangeable.
  - 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  - 8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
  - 9. Overpressure Protection Device: Factory mounted on pressure regulator.
  - 10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
  - 11. Maximum Inlet Pressure: 35 psig (241.5 kPa); regulate to 5 psi downstream.
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
  - 1. Body and Diaphragm Case: Die-cast aluminum.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm Plate: Zinc-plated steel.
  - 4. Seat Disc: Nitrile rubber.
  - 5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  - 6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
  - 7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
  - 8. Maximum Inlet Pressure: Regulate to 7 inches wc downstream.

## **2.5 MANUAL GAS SHUTOFF VALVES**

- A. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
  - 1. CWP Rating: 125 psig (862 kPa).
  - 2. Threaded Ends: Comply with ASME B1.20.1.



3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
  6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig (862 kPa).
  2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
  2. Ball: Chrome-plated brass.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.
  5. Packing: Separate packnut with adjustable-stem packing threaded ends.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
  2. Ball: Chrome-plated bronze.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.
  5. Packing: Threaded-body packnut design with adjustable-stem packing.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
  2. Ball: Chrome-plated bronze.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE.
  5. Packing: Threaded-body packnut design with adjustable-stem packing.
  6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
  2. Plug: Bronze.
  3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Operator: Square head or lug type with tamperproof feature where indicated.
  5. Pressure Class: 125 psig (862 kPa).
  6. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
  2. Plug: Bronze or nickel-plated cast iron.
  3. Seat: Coated with thermoplastic.
  4. Stem Seal: Compatible with natural gas.
  5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

6. Operator: Square head or lug type with tamperproof feature where indicated.
  7. Pressure Class: 125 psig (862 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
  2. Plug: Bronze or nickel-plated cast iron.
  3. Seat: Coated with thermoplastic.
  4. Stem Seal: Compatible with natural gas.
  5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  6. Operator: Square head or lug type with tamperproof feature where indicated.
  7. Pressure Class: 125 psig (862 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- I. Gas Vent Cocks: Type 701: Bronze body, tee handle, rated for 205 kPa at 38°C (30 psi at 100°F), ground plug, rated for tight shut-off on fuel gas service.

## **2.6 WATERPROOFING**

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- C. Walls: See detail shown on drawings.

## **2.7 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Gas Lines: "Y" type with removable mesh lined brass strainer sleeve.

- C. Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi-steel.

## **2.8 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

## **2.9 GAS EQUIPMENT CONNECTORS**

- A. Flexible connectors with teflon core, interlocked galvanized steel protective casing, AGA certified design.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. General: Comply with the International Fuel Gas Code and the following:
  - 1. Install branch piping for fuel gas and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
  - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, shall be reamed to full size after cutting.
  - 3. All pipe runs shall be laid out to avoid interference with other work.
  - 4. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible.
  - 5. Install union and shut-off valve on pressure piping at connections to equipment.
  - 6. Pipe Hangers, Supports and Accessories:
    - a. All piping shall be supported per the International Fuel Gas Code, Chapter No. 4.
    - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
    - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
      - 1) Solid or split unplated cast iron, chrome plated in finished areas.
      - 2) All plates shall be provided with set screws.
      - 3) Pipe Hangers: Height adjustable clevis type.
      - 4) Adjustable Floor Rests and Base Flanges: Steel.
      - 5) Concrete Inserts: "Universal" or continuous slotted type.
      - 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
      - 7) Riser Clamps: Malleable iron or steel.
      - 8) Rollers: Cast iron.

- 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
- 10) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories.
- 7. Install cast chrome plated escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- 8. Penetrations:
  - a. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- B. Piping shall conform to the following:
  - 1. Fuel Gas:
    - a. Entire fuel gas piping installation shall be in accordance with requirements of NFPA 54.
    - b. Provide fuel gas piping with plugged drip pockets at low points.
    - c. Emergency Gas Shut-off: Provide at location within building as directed by Resident Engineer.

**3.2 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG (34.5 kPa)**

- A. Aboveground Piping: Maximum operating pressure no more than 35 psig (241.5 kPa).
- B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be the following:
  - 1. Steel pipe with steel welding fittings and welded joints.

**3.3 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller for main shut-off shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger for main shut-off shall be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Cast-iron, nonlubricated plug valve.

- C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Cast-iron, nonlubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.

### **3.4 CLEANING OF SYSTEM AFTER INSTALLATION**

- A. Clean all piping systems to remove all dirt, coatings and debris.

### **3.5 TESTS**

- A. General: Test system either in its entirety or in sections after system is installed or cleaned.
- B. Test shall be made in accordance with Section 406 of the International Fuel Gas Code. The system shall be tested at a minimum of 1.5 times maximum working pressure, but not less than 3 psig (20 kPa) gage).

### **3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

### **3.7 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -

**SECTION 23 12 34**

**FUEL GAS COMPRESSOR**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for natural gas compressor system used in conjunction with the gas turbine generator system, including compressors, electric motors and starters, receiver, all necessary piping, fittings, valves, gages, switches and all necessary accessories, connections and equipment.
- B. The natural gas compression system specified herein is part of an integrated 'co-generation' (co-gen) or combined heat and power (CHP) system consisting of the CTG, the Heat Recovery steam generator (HRSG), the PLC control system, the natural gas compression system, and the continuous emissions monitoring system. It is the intent of these specifications that the CHP system be furnished complete as a system with a single source of responsibility to coordinate the procurement of the associated components to insure compatibility and performance. Refer to Section 26 32 14, Combustion Turbine Generator, for language regarding 'packaging' and single source responsibility and Section 25 60 00, CHP PLANT CONTROL SYSTEM, for language regarding 'system integrator' for controls.
- C. The manufacturer shall design, fabricate, assemble, factory test, deliver, and provide startup and commissioning supervision and training for one (1) natural gas compressor system, complete with all components and features as specified. The natural gas compressor system shall each be of a single skid mounted construction, with all components mounted on skid. Skid shall be complete and ready for hooking up interconnecting piping, power, and interconnecting control wiring and the external connections to make the system operative.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Section 23 11 23, FACILITY NATURAL GAS PIPING.
- F. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: High pressure natural gas piping.

- G. Section 25 60 00, CHP PLANT CONTROL SYSTEM.
- H. Section 26 29 11, MOTOR STARTERS.
- I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- J. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- K. Section 26 32 14, COMBUSTION TURBINE GENERATOR.

### **1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data shall be submitted for the following products:
  - 1. Supporting elements.
  - 2. Pressure Gages.
  - 3. Pressure Reducing and Regulating Valves.
  - 4. Automatic drain valves.
  - 5. Filter capacity and operating characteristics.
  - 6. Vibration Isolation.
  - 7. Control Panel and Alarm System.
  - 8. Compressor System:
    - a. Characteristic performance curves.
    - b. Sound ratings measured in dBA.
    - c. Efficiency.
    - d. Compressor; manufacturer and model.
    - e. Compressor operating speed.
    - f. Capacity; (CFH at discharge pressure).
    - g. Stroke, piston speed.
    - h. Type of lubrication.
    - i. Capacity of cooling fan and motor size.
    - j. Unloader; manufacturer, type, and model.
    - k. Type and adjustment of drive.
    - l. Electrical motor; manufacturer, frame and model.
    - m. Speed of motor.
    - n. Current characteristics and HP of motor.
    - o. Oil cooler; manufacturer, type, and model.
    - p. After cooler; manufacturer, type, and model.
  - 9. Compressor Acoustic Enclosure: Product data including sound rating for enclosure measured in dBA.



C. Drawing Requirements (not all inclusive):

1. Final equipment layouts shall include arrangement drawings in plan and elevation, with all major components identified. Product and service tie-ins shall be identified by size, type and dimensions for locating tie-ins. Access clearances for service of equipment and removal of components shall also be shown. Mechanical interfaces to other systems or utilities shall be clearly identified and dimensioned, including size and type of connection. Detailed location and characteristics of all terminal points, electric connection requirements, etc. shall be provided.
2. Elevations and sections shall be provided as necessary to show full details of tie-ins, service access and control components.
3. P&ID diagrams.
4. Control Seismic Diagrams - including control logic. Include page and/or rung comment, or Logic Diagram in sufficient detail to allow for the future maintenance of the system.
5. Field Electrical Wiring Diagrams.
6. Overall dimensions and detailed floor loading shall be shown.

D. Brazing and welding certificates shall be submitted.

E. For Seismic Restraint design the following shall be submitted:

1. Dimensioned drawings of equipment identifying center of gravity and location and description of seismic mounting and anchorage systems.

F. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI)/American society of Mechanical Engineers (ASME):
1. A13.1- 07 Scheme for the Identification of Piping Systems
- C. American Petroleum Institute (API)
1. 11P-89 Specification for Packaged High Speed Separable Engine Driven Reciprocating Gas Compressors

2. 618-95 Reciprocating Compressors for General Refinery Services

D. National Fire Protection Association (NFPA):

1. 99-2005 Health Care Facilities

#### **1.5 AS-BUILT DOCUMENTATION**

- A. The electronic documentation and copies of the Operations and Maintenance Manual, approved submittals, shop drawings, and other closeout documentation shall be prepared by a computer software program complying with Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C 794d). The manufacturer or vendor of the software used to prepare the electronic documentation shall have a Voluntary Product Accessibility Template made available for review and included as part of the Operations and Maintenance Manual or closeout documentation. All available accessibility functions listed in the Voluntary Accessibility Template shall be enabled in the prepared electronic files. As Adobe Acrobat is a common industry format for such documentation, following the document, "Creating Accessible Adobe PDF files, A Guide for Document Authors" that is maintained and made available by Adobe free of charge is recommended."
- B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- C. Four sets of operation and maintenance data updated to include submittal review comments shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

#### **1.6 INSTALLATION, COMMISSIONING AND STARTUP SERVICES**

- A. The Manufacturer shall provide the necessary services to assist in the installation and assembly of the work provided, field commissioning and startup services to fully commission the equipment to achieve performance guarantees. This service shall include, but not be limited to, verification of proper installation, performance of all tests and procedures as stated in the startup and installation manuals, verification of the proper operation of the control panels to perform as designed, performance of all necessary adjustments and calibrations of all unit sensors and meters and necessary technical assistance to assure that the Manufacturer's equipment meets the performance guarantees. The Manufacturer shall make all reasonable efforts to insure that the same service technician is utilized for startup, training and commissioning.

- B. Additional hands on training shall be provided on an informal basis, as time permits, by the Manufacturer's representative during plant startup and commissioning.

#### **1.7 TRAINING**

- A. The Manufacturer shall provide on-site training for up to 5 operating and maintenance personnel. This service shall include operating instructions and training for Owner's personnel. Instructions shall include, but not be limited to, training materials, hands-on and classroom instruction and complete review of all manuals. Classroom training shall be performed for two groups of personnel in a maximum of 2-8 hour daily sessions. The hands-on instructions shall include startup, operation (normal and expected transients), shutdown and maintenance.

#### **1.8 SPARE PARTS**

- A. Manufacturer shall identify all spare parts, including source, cost and identification of the manufacturer and associated model number, critical to initial startup that are recommended for the Owner to have on-hand to minimize unplanned construction delays or equipment downtime, as well as a standard priced spare parts list for replacement of components as needed. The Manufacturer shall recommend spare parts expected for replacement during two (2) years of operation.

#### **1.9 SPECIAL TOOLS**

- A. The Manufacturer shall furnish one (1) set of new special tools normally provided for the system proposed.

### **PART 2 - PRODUCTS**

#### **2.1 REFER ALSO TO SECTION 23 21 11, COGENERATION PLANT PIPING SYSTEMS**

#### **2.2 GAS COMPRESSOR**

- A. Fuel gas boost compressor shall be of the horizontal opposed reciprocating piston design and including crosshead guides. The compressor shall be a balanced-opposed design and have fully machined crankshaft to provide optimum balance and vibration free operation. Units shall be designed in accordance with API Standards 11P and 618.

1. Compressor Materials:

<b><u>Components</u></b>	<b><u>Material</u></b>
Crankcase	Grey iron
Crosshead guides	Grey iron
Crankshaft	Ductile iron
Connecting rods	Ductile iron 60-40-18

Connecting rod bearings	Steel backed babbit
Main bearings	Double row spherical roller
Connecting rod bushings	Phosphor bronze
Crossheads	Ductile iron 60-40-18 babbitt faced
Crosshead pin	Alloy steel 8620
Crosshead pin bushings	660 bronze
Piston rod	Alloy steel 4140
Rod packing rings	Non metallic full floating
All stress bolts	High tensile alloy
Pistons	Steel, grey iron, or alum
Standard piston rings	Non metallic
Standard rider rings	Non metallic
Valve cover O rings	Viton
Valve seats	Carbon steel
Valve guards	Carbon steel

- B. The frame shall be pressure lubricated including crosshead guide, wrist pin bushings, connecting rod bearings and (spray) main bearing.
- C. The compressor shall be equipped with double acting or tandem, single acting cylinders as needed to meet the configuration requirements of the application. The maximum allowable working pressure shall be at least 10% over the maximum operating pressure of the application. Cylinder shall be hydro tested at two times the maximum allowable working pressure. Design temperature of the cylinder shall be 350 Deg F with maximum operating temperature being less than 300 Deg F.
- D. Compressor package shall include air cooled intercooler and aftercooler sections. Cooler assembly shall be forced draft type designed for gas approach temperature of 20 Deg F to site design temperature (93 Deg F). Fan shall be driven by electric motor.
- E. Provide the following features:
1. Piston/rider and packing rings material to be compatible with the specified gas and service.
  2. Non-cooled double acting cylinders.

3. Non-interchangeable compressor valves of the plate design.
  4. Variable head end clearance pockets on each cylinder.
  5. Lubricated cylinders and packing.
  6. Motor driven cylinder lubricator.
  7. Motor driven oil pump to accommodate variable speed drive.
  8. Minimum four hour run test of compressor to insure proper fit up.
  9. Special tools kit containing tools required for compressor maintenance and repair that would not be considered normal mechanics tools.
  10. Compressor to be mounted on a rigid structural steel skid.
  11. Direct motor driven - coupling, flywheel and non sparking guards required, 250 HP TEFC 460/3/60 motor with thermostats for hazardous area.
  12. Inlet connection shall be at skid edge, piped to 1st stage suction vessel and shall include removable startup screen.
  13. Coalescing filter with 1 micron retention rating at discharge.
  14. Separator at suction of both stages. Separators shall be designed for adequate pulsation suppression at suction.
  15. Liquid level drain control for separators and filter.
  16. Pulsation vessels shall be provided at outlet of each cylinder.
  17. Interstage piping with relief valves at each stage.
  18. Air cooled intercooler, aftercooler, and oil cooler.
  19. Control panel suitable for the service in a NEMA 4 enclosure. Controls shall be intrinsically safe, suitable for the hazardous area. Controls will be based on standard fuel gas boost system.
  20. Pressure and temperature indication shall be on display screen.
  21. Discharge to inlet block and bypass loop for capacity control.
  22. Variable frequency control to vary motor speed from 50 percent to 100 percent capacity. Controller to be installed in non-hazardous area by others.
- F. Acoustic enclosure designed to reduce noise levels. The enclosure shall be rated for noise level not to exceed 65 dBA at a distance of three feet. Enclosure will include electric lights suitable for hazardous area. Provide gas detection system to shutdown equipment in case of leakage.

### **2.3 STRUCTURAL SKID**

- A. Supply a structural steel skid, designed in accordance with AISC Manual of Steel Construction. For reciprocating compressors, the skid shall be concrete filled under the compressor/motor pedestal.
- B. Components shall be mounted with anchor bolts to structural members.
- C. Access area skid surfaces shall be 1/4 inch checkered plate.

- D. A total flooded and dry skid weight estimate, including all components, is to be included on the Approval Drawings.
- E. Skid stiffness shall be of such magnitude to prevent any local resonances.
- F. A 2" drip lip or suitable containment barrier shall be provided around the compressor. Drain connection shall terminate at skid edge.
- G. Lifting lugs shall be provided by the Supplier, and designed for a single lift of the compressor skid. Supplier shall furnish spreader bars, slings and shackles, if required.

#### **2.4 INSTRUMENTATION**

- A. Provide a fuel gas compressor system control panel complete with all associated process instruments, annunciators, power supplies, pushbuttons, lights, and accessories. The panel shall be furnished in a NEMA 4x enclosure, completely wired, programmed, and functional.
- B. Unless indicated otherwise, the panel shall be skid-mounted and suitable for the area classification of location installed. The panel shall utilize a PLC. The panel logic shall be designed for valve sequencing and alarm/shutdown functions for fully automated compressor package. HMI screen shall be 10 inches or larger.
- C. Provide a Modbus or Ethernet connection for monitoring and alarming through the FMCS.
- D. Shutdowns, with panel annunciation, shall include, but not be limited to:
  - 1. Compressor low oil pressure
  - 2. Compressor lubricator no-flow
  - 3. Compressor vibration
  - 4. Compressor low oil level
  - 5. Cylinder high discharge temperature, for each cylinder
  - 6. Vessel high liquid level, for each scrubber or filter-coalescer
  - 7. Low suction pressure, skid and interstage
  - 8. High suction pressure
  - 9. High interstage pressure, if applicable
  - 10. Low discharge pressure
  - 11. High discharge pressure
  - 12. Remote stop
  - 13. Cooler vibration
  - 14. Low discharge Delta temperature (less than 50 deg F superheat).
  - 15. High discharge temperature alarm (195 deg F) and shutdown (200 deg F)
  - 16. Motor vibration

- E. The skid wiring method shall be suitable for Class I, Division 2, Group D areas.
- F. All tubing and fittings shall be 316 stainless steel. Tubing fittings shall be Swagelok. Other threaded connections shall be sealed with a suitable sealant.
- G. All instrument items contacting process gas shall be stainless steel.

## **2.5 ELECTRICAL**

- A. All electrical components shall be suitable for Class I, Division 2, Group D area classification, or as noted on the system Specification sheets. Wiring system shall be armored cables.
- B. The required power feeders for the main drive motor and other motors shall be installed by others. Power connections will be made directly to the motors. Control connections will be made at the skid mounted panel or skid mounted junction box (if panel is to be located off-skid). Cable wireways to be provided for customer-provided motor load and control cabling.
- C. The complete electrical installation of skid shall comply with the requirements of the National Electrical Code and applicable industry standards as referenced in article, Applicable Publications.

## **PART 3 - EXECUTION**

### **3.1 COMPRESSOR SKID**

- A. Secure skid to substrate with anchors as detailed on plans or otherwise specified.

### **3.2 TESTS**

- A. Make tests under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of compressors shall be performed simultaneously with the compressed fuel and cogeneration system of which each compressor is an integral part.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all

inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -



**SECTION 23 21 11**

**COGENERATION PLANT PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. All cogeneration plant piping systems, except plumbing and sanitary, including piping supports. Piping located outside of the cogeneration plant building is not included except for gas regulator and meter stations.
- B. Includes feedwater piping from new pump in existing boiler plant to the new HRSG in Cogeneration Plant.

**1.2 RELATED WORK:**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR COGENERATION PLANT and STEAM GENERATION
- F. Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.
- G. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.
- H. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING .
- I. Section 22 31 11, WATER DEIONIZER.
- J. Control valves: Section 23 52 35, HEAT RECOVERY STEAM GENERATORS.
- K. Control valves: Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT.
- L. Flow Meters: Section 25 60 00, CHP PLANT CONTROL SYSTEM and Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.

**1.3 QUALITY ASSURANCE:**

- A. Entire installation shall comply with ASME Power Piping Code, ASME B31.1 and appendices.

- B. Boiler External Piping, as defined in the ASME Boiler and Pressure Vessel Code, Section I, is required to be constructed and inspected in conformance with the ASME Code.
- C. Mechanics shall be skilled in their work or trade. Welders on pressure vessels or piping shall show evidence of qualification in accordance with the ASME Power Piping Code and the ASME Boiler and Pressure Vessel Code. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current. Each welder shall utilize a stamp to identify all work performed by the welder. The Government reserves the right to reject any personnel found unqualified in the performance of work for which they are employed.
  - 1. Submit for approval the names, identification, and welder's assigned number, letter or symbol of welders assigned to this project.
  - 2. The assigned identification symbol shall be used to identify the work of each welder and shall be indelibly stamped immediately upon completion of each weld above.
  - 3. Welders shall be tested and certified for all positions.
  - 4. Submit identifying stenciled test coupons made by each operator.
  - 5. Any or all welders may be required to retake welding certification tests without additional expense.
  - 6. When so requested, a welder shall not be permitted to work as a welder on this project until he has been recertified in accordance with requirements above.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Piping:
  - 1. ASTM material specification number.
  - 2. Grade, class or type, schedule number.
  - 3. Manufacturer.
- C. Pipe Fittings, Unions, Flanges:
  - 1. ASTM material specification number.
  - 2. ASME standards number.
  - 3. Catalog cuts.
  - 4. Pressure and temperature ratings.
- D. Valves - Gate, Globe, Check, Plug, Butterfly, Ball:
  - 1. Catalog cuts showing design and construction.
  - 2. Pressure and temperature ratings.
  - 3. Materials of construction.

4. Accessories.
- E. Sight flow indicators:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
- F. Quick-Couple Hose Connectors and Steam Hose:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
  4. Type of seal between couplings.
  5. Flexibility of steam hose.
- G. Pressure Reducing and Regulating Valves, Back Pressure Relief Valves, Safety Valves, Relief Valves:
1. Catalog cuts showing design and construction.
  2. Service limitations (type of fluid, maximum pressure and temperatures).
  3. Materials of construction.
  4. Flow capacity at required set pressure.
  5. Predicted sound levels, at operating condition, for steam pressure reducing valves.
- H. Strainers:
1. Catalog cuts showing design and construction.
  2. Pressure and temperature ratings.
  3. Materials of construction.
  4. Strainer basket or liner mesh.
  5. Pressure loss and flow rate data.
- I. Emergency Gas Safety Shutoff Valves, Automatic Earthquake Gas Valves:
1. Catalog cuts showing design and construction.
  2. Maximum pressure rating.
  3. Material of construction.
  4. Pressure loss and flow rate data.
- J. Steam Traps:
1. Catalog cuts showing design and construction.
  2. Service limitations (maximum pressures and temperatures).
  3. Materials of construction.

4. Flow rates at differential pressures shown on drawings.
5. Orifice size for each trap.

K. Flexible Connectors:

1. Catalog cuts showing design and construction.
2. Pressure and temperature ratings.
3. Materials of construction.
4. Maximum allowable lateral and axial movements.
5. Description of type of movement permitted, intermittent offset or continuous vibration.

L. Pipe Support Systems:

1. Credentials of technical personnel who will design the support systems.
2. Validation of computer program for pipe support selection.
3. Input and output data for pipe support selection program for all piping systems with pipe sizes 60 mm (2-1/2 inches) and above.
4. Boiler and feedwater deaerator steam nozzle (pipe connection) allowable and actual forces and moments imposed by connecting piping.
5. Hanger load calculation methods and results for piping systems with pipe sizes 50 mm (2 inches) and below.
6. Piping layouts showing location and type of each hanger and support.
7. Catalog cuts showing design and construction of each hanger and support and conformance of hangers and supports to MSS standards.
8. Drawings showing arrangement and sizes of all components comprising each spring-type hanger and support assembly.
9. Load rating and movement tables for all spring hangers, and seismic shock absorbing devices.

M. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:**

- A. All piping shall be stored and kept free of foreign material and shall be internally and externally cleaned of all oil, dirt, rust and foreign material. Deliver and store valves and pipe hangers in sealed shipping containers with labeling in place. Storage must be in dry, protected location.

**1.6 INFORMATION ON PRESSURE-TEMPERATURE DESIGN OF PIPING SYSTEMS:**

- A. Steam service pressures are selected to provide optimum pressure to the facilities served by the boiler plant and co-generation plant. Main steam header pressure shall be controlled at 620 kPa (90 psi). Maximum pressure capability of steam systems between boilers and through first pressure reducing valve protected by a safety valve shall be governed by the pressure/temperature relationship of the highest safety valve setting shown for the boilers.
- B. Steam distribution systems protected by safety valves following pressure reducing stations or protected by safety valves on the boilers shall be governed by the pressure/temperature relationship developed by the maximum setting of the safety valve on that system.
- C. Boiler feedwater systems between boiler feed pumps, economizers (if provided), and boilers are designed for a normal maximum temperature of 138 deg C (280 deg F) and emergency temperature of 213 deg C (415 deg F) (if economizers are provided and economizer safety relief valve setting is 1896 kPa (275 psi)). Design pressure is the greater of: boiler feed pump shut off head; or 1896 kPa (275 psi) set pressure, plus accumulation, of economizer (if provided) relief valve.
- D. Condensate collection and transfer systems to suction of boiler feed pumps are designed for maximum temperatures to 100 deg C (212 deg F) and pressures 276 kPa (40 psi). Vacuum return systems shall operate between 0 and 27 kPa (0 and 8 inch Hg) vacuum and equivalent steam saturation temperatures.
- E. Natural gas fuel systems are designed and materials and equipment are applied to prevent failure under gas pressure of 2068 kPa 300 psi entering Government property.
- F. Water service pressures are 551 kPa (80 psi) maximum. Systems are designed to operate under conditions of maximum available pressure.
- G. Drips, drains, blowdown, water sampling, and chemical treatment are designed, and materials and equipment are applied in accordance with the maximum pressure and temperature of the system with which they are associated.
- H. Low pressure steam, condensate and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psi) saturated steam.
- I. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).
- J. Instrumentation and control piping shall be provided for the service and pressure characteristics of the systems to which they are connected.

**1.7 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. ASTM International (ASTM):

1. A47/A47M-99(2009) Standard Specification for Ferritic Malleable Iron Castings
2. A48/A48M-03(2008) Standard Specification for Gray Iron Castings
3. A53/A53M-07 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
4. A105/A105M-10 Standard Specification for Carbon Steel Forgings for Piping Applications
5. A106/A106M-08-06a Standard Specification for Seamless Carbon Steel Pipe For High Temperature Service
6. A126-04(2009) Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
7. A182/A182M-1/a Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Fittings, Forged Fittings and Valves and Parts for High Temperature Service
8. A193/A193M-10a Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
9. A194/A194M-10 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
10. A197/A197M-00(2006) Standard Specification for Cupola Malleable Iron
11. A216/A216M-08 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High Temperature Service
12. A234/A234M-10 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
13. A269-10 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
14. A312/A312M-11 Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes
15. ASTM A351/A351M-10 Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
16. A395/A395M-99(2009) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for use at Elevated Temperatures
17. ASTM A403/A403M-11 Standard Specification for Wrought Austenitic Stainless Steel Fittings
18. A536-84(2009) Standard Specification for Ductile Iron Castings
19. B61-08 Standard Specification for Steam or Valve Bronze Castings
20. B88/B88M-03 Standard Specification for Seamless Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code: 2010 Edition with current Addenda
2. Section I                      Power Boilers
3. Section IX                    Welding and Brazing Qualifications
4. B16.3-2006                    Malleable Iron Threaded Fittings
5. B16.4-2006                    Gray Iron Threaded Fittings
6. B16.5-2009                    Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24
7. B16.9-2007                    Factory Made Wrought Buttwelding Fittings
8. B16.11-2009                  Forged Fittings, Socket-Welding and Threaded
9. B16.20-1998                  Metallic Gaskets for Pipe Flanges-Ring-Joint, Spiral Wound and Jacketed
10. B16.22-2001 (R2005)        Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
11. B31.1-2010    Power Piping

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

1. SP-45-2003                    Bypass and Drain Connections
2. SP-58-2009                    Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application, and Installation
3. SP-69-2003                    Pipe Hangers and Supports-Selection and Application
4. SP-80-2008                    Bronze, Gate, Globe, Angle and Check Valves
5. SP-89-2003                    Pipe Hangers and Supports-Fabrication and Installation Practices
6. SP-90-2000                    Guidelines on Terminology for Pipe Hangers and Supports
7. SP-97-2006                    Integrally Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded and Buttwelding Ends
8. SP-127-2001                  Bracing for Piping Systems Seismic - Wind - Dynamic Design, Selection, Application

E. American Welding Society (AWS):

1. B2.1-2009    Specification for Welding Procedure and Performance Qualification

F. Pipe Fabrication Institute (PFI):

1. ES24-R08    Pipe Bending Methods, Tolerances, Process and Material Requirements

## **PART 2 - PRODUCTS**

### **2.1 STEAM PIPING:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or electric resistance welded (ERW). Schedule 40 for piping up to 862 kPa (125 psig) with welded ends, Schedule 80 for piping with threaded ends and piping over 862 kPa (125 psig) with welded ends. Standard weight permitted for pipe sizes 300 mm (12 inches) and above.
- B. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded
  - 2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded, or socket-welded.
- C. Fittings:
  - 1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius.
  - 2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
  - 3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi) class.
- D. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) on piping 50 mm (2 inches) and under.
- E. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi) pressure class, except 2050 kPa (300 psi) class required adjacent to 1725 kPa (250 psi) and 2050 kPa (300 psi) class valves. Bolts shall be high strength steel ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

### **2.2 STEAM CONDENSATE PIPING:**

- A. Includes all gravity, drip return, pumped and vacuum systems. Does not include piping system between boiler feed pumps and boilers.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 80.
- C. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded or socket-welded.
- D. Fittings:
  - 1. Welded joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.



2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
  3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.
- E. Unions on Threaded Piping: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (30 psi). On piping 50 mm (2 inches) and under.
- F. Flanges: Forged steel weld neck, ASTM A105, ASME B16.5, 1025 kPa (150 psi).

### **2.3 HIGH PRESSURE FUEL PIPING:**

- A. Natural gas. Comply with ASME B31.1.
- B. Piping: Stainless steel ASTM A312-TP 304/304L, Schedule 40L.
- C. Joints:
1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  2. Pipe sizes 50 mm (2 inches) and below: Socket-welded or butt-welded.
- D. Fittings:
1. Butt-welded joints: Stainless steel, ASTM A403-WP 304/304L, seamless, same schedule as adjoining pipe.
  2. Socket-welded joints: Forged steel, ASME B16.11, 20,684 kPa (3000 psi class, ASTM A182-F304/304L.
- E. Unions on piping 50 mm (2 inches) and under: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class.
- F. Flanges: Stainless steel weld neck, ASME B16.5, ASTM A182-F304/304L, 2068 kPa (300 psi).
- G. Bolting: ASTM A-193, B7 stud, with two heavy hex nuts, ASTM A-194, Gr. 2H.
- H. Companion flanges: Flanges and bolting shall conform to ASME B16.5.
- I. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B31.1, for the actual operating conditions.

### **2.4 FEEDWATER PIPING:**

- A. Piping from feedwater pump discharge to inlet of HRSG.
- B. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW. Piping with threaded joints shall be Schedule 80; welded joints Schedule 40.

C. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
2. Pipe sizes 50 mm (two inches) and below: Threaded, butt-welded, or socket-welded.

D. Fittings:

1. Butt-welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
2. Threaded Joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class; or malleable iron, ASTM A47, ASME B16.3, 2050 kPa (300 psi) class.
3. Socket-welded joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable or ductile iron, 2050 kPa (300 psi) class.

F. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi) pressure class. Bolts shall be High strength ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.

**2.5 HRSG BLOWOFF PIPING:**

- A. From boiler bottom blowoff connection to blowoff tank. Connections between boiler accessories drain valves and blowoff lines.
- B. Pipe: Carbon steel, ASTM A106, Grade B, seamless, Schedule 80.
- C. Joints: Butt-welded.
- D. Fittings: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius, no tees or crosses permitted.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 2050 kPa (300 psi).

**2.6 DRAIN PIPING FROM HRSG ACCESSORIES TO DRAIN VALVE:**

- A. Drain piping from water column, low water cutoffs, gage glass, water level sensor, remote water level devices (where applied).
- B. Pipe: Carbon steel, ASTM A106, seamless, Schedule 40.
- C. Joints: Threaded.
- D. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class.
- E. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 2050 kPa (300 psi) class.

**2.7 VENT LINES FROM TANKS AND SAFETY AND RELIEF VALVES:**

- A. Pipe: Carbon steel, ASTM A53 Grade B or A106 Grade B, seamless or ERW, Schedule 40.
- B. Joints:
  - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded.
  - 2. Pipe sizes 50 mm (2 inches) and below: Threaded or butt-welded.
- C. Fittings:
  - 1. Welded Joints: Steel, ASTM A234 Grade B, ASME B16.9, same schedule as adjoining pipe.
  - 2. Threaded Joints: Cast iron, ASME B16.4, 850 kPa (125 psi).
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

**2.8 COLD WATER PIPING:**

- A. Soft Water: See Section 22 31 11, WATER - DEIONIZER.
- B. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

**2.9 COMPRESSED AIR PIPING (GENERAL SERVICE):**

- A. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW Schedule 40.
- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron ASTM A47 or A197, ASME B16.3, 1025 kPa (150 psi) class.
- D. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, 1025 kPa (150 psi) class.

**2.10 COMPRESSED AIR AND BOILER DRAFT GAGE PIPING (PNEUMATIC CONTROL AND INSTRUMENTATION):**

- A. Air drier to utilization point; draft gage sensing lines.
- B. Copper tubing, hard drawn, ASTM B88, Type L.
- C. Fittings: Wrought copper, ASME B16.22, soldered.
- D. Draft Gage Piping: 6 mm (1/4 inch) pipe size minimum.

**2.11 HRSG WATER SAMPLING, CONTINUOUS BLOWDOWN:**

- A. Pipe: Steel, ASTM A106 Grade B, seamless, Schedule 80.

- B. Joints: Threaded.
- C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class. Fittings between boiler and first stop valve must be forged steel, ASME B16.11, 13,790 kPa (2000 psi) or 20,700 kPa (3000 psi) class.
- D. Unions: Malleable iron, 2050 kPa (300 psi) class.

**2.12 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING:**

- A. Pipe: Stainless steel tubing, ASTM A269, Type 316.
- B. Fittings: Stainless steel Type 316 welding fittings.

**2.13 MISCELLANEOUS PIPING:**

- A. Instrument and Control Piping (Sensing Point to Transmitter, Controller, or Other Instrument): Construction shall be same as specified for main service.
- B. Drain Piping (All Drain Piping Discharging to Floor Drain-From Drain Valve to Floor Drain):
  - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40.
  - 2. Fittings and Unions: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, 1025 kPa (150 psi), threaded.
- C. Pump Recirculation:
  - 1. Pipe: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, double extra strong. Schedule 40 permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
  - 2. Joints: Threaded.
  - 3. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psi class); or malleable iron, ASTM A47 or A197, ASME B16.3, 2050 kPa (300 psi) class, except 1025 kPa (150 psi) class permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.
  - 4. Unions: Forged steel, 13,800 kPa (2000 psi) class or 20,680 kPa (3000 psi) class; or malleable iron, ASTM A47 or A197, same pressure class as nearest fittings.
- D. Lube Oil Piping: Comply with ASME B31.1.
  - 1. Piping: Stainless steel ASTM A312-TP 304/304L, Schedule 40 for line sizes through 1-1/2 inch and Schedule 10 for 2 inch and larger.
  - 2. Joints:
    - a. Pipe sizes 12.7 mm (1/2 inch) through 50.8 mm (2 inches), 3000 lb. stainless steel unions, ASTM A182-F304/304L, integral seat, socket weld ends or 150 lb RF stainless steel flanges ASTM A182-F304/304L, per ANSI B16.5. socket weld type.

- b. Pipe sizes (2-1/2 inches) and larger: 150 lb. RF stainless steel flanges, ASTM A182-F304/304L, per ANSI B16.5, socket weld type.
- 3. Fittings:
  - a. 2 inch and larger, butt-welded joints: Stainless steel, ASTM 403-WP 304/304L, seamless, same as schedule as adjoining pipe.
  - b. 1-1/2 inch and smaller, socket-welded joints: Forged steel, ASME B16.11, 20684 kPa (3000 psi class, ASTM A182-F304/304L).
- 4. Flanges: Stainless steel weld neck, ASME B16.5, ASTM A182-F304/304L, 2068 kPa (300 psi).
- 5. Bolting: ASTM A-193, B7 stud, with two heavy hex nuts, ASTM A-194, Gr. 2H.

#### **2.14 DIELECTRIC FITTINGS:**

- A. Provide threaded dielectric unions for pipe sizes 50 mm (2 inches) and under. For 65 mm (2-1/2 inches) and above, provide copper and steel flanges electrically isolated at gasket and by sleeves at bolts. Fittings on cold water and soft water lines shall be rated for 690 kPa (100 psi), 27 deg C (80 deg F). Fittings on steam condensate lines shall be rated at 510 kPa (75 psi), 120 deg C (250 deg F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

#### **2.15 VALVES; GATE, GLOBE, PLUG, CHECK, BALL, BUTTERFLY, VENT COCKS:**

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer. Comply with MSS SP-45, MSS SP-80, and ASME B31.1. Design valves for the service fluids and conditions. Pressure-temperature ratings listed are minimum requirements. Packing and gaskets shall not contain asbestos.
- B. Valve Type Designations:
  - 1. Gate Valves:
    - a. Type 101: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 deg C 150 psi at 500 deg F) 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet.
      - 1) Provide factory installed globe-valved warm-up bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
      - 2) Drill and tap bosses for connection of drains. Conform to MSS SP-45.
    - b. Type 102: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze wedge and seats, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
      - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.

- 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
  - c. Type 103: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze faced wedge and seats, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
    - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6 m (20 feet). Conform to MSS SP-45.
    - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
  - d. Type 104: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze wedges and Monel or stainless steel seats, threaded ends, rising stem, union bonnet.
  - e. Type 105: Forged steel body ASTM A105, rated for 2050 kPa at 216 deg C 300 psi at 420 deg F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
- 2. Globe Valves:
  - a. Type 201: Cast steel body ASTM A216 WCB, rated for 1025 kPa at 260 deg C 150 psi at 500 deg F) 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1025 kPa (150 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
  - b. Type 202: Cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
  - c. Type 203: Cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (125 psi) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
  - d. Type 204: Bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.
  - e. Type 205: Forged steel body ASTM A105, rated for 2050 kPa at 216 °C (300 psi at 420 °F) minimum, Class 4130 kPa (600 psi) or Class 5500 kPa (800 psi), stainless steel disc, stellite seat, threaded ends, OS&Y, rising stem, bolted bonnet.
- 3. Plug Valves: Cast iron body ASTM A126 Class B, rated for 1200 kPa (175 psi) WOG, one-fourth turn to open. 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. All components designed for service to which applied: low pressure natural gas to gas compressor. Furnish lever handle for each valve.

- a. Type 301: Two-way valves up through 100 mm (4 inches) pipe size. Eccentric action, non-lubricated plug with resilient seal molded into groove on plug face providing bubble-tight shut off. O-ring stem seal, corrosion-resistant bearings, corrosion-resistant seat coating, seal materials as recommended by valve manufacturer for the service. Valves on natural gas service AGA approved.
  - b. Type 302: Two-way valves 125 mm (5 inches) pipe size and above, all sizes of three way valves. Lubricated full-port plug type with lubricant for intended service. Reinforced Teflon stem seal, valve plug floated on Teflon surfaces, lubricant injection system that has sufficient pressure to fully lubricate all sealing surfaces. Provide laminated plastic label attached to each valve stating, "Lubricate with (Insert appropriate description) once a year".
4. Check Valves:
  - a. Type 401: Not used.
  - b. Type 402: Swing-type, cast iron body ASTM A126 Class B, rated for 1725 kPa (250 psi) saturated steam, 3440 kPa (500 psi) WOG, bronze or bronze-faced disc and seat, 1725 kPa (250 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - c. Type 403: Swing-type, cast iron body ASTM A126 Class B, rated for 850 kPa (125 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (125 psi) ASME flanged ends, bolted cover, renewable disc and seat.
  - d. Type 404: Swing-type, bronze body ASTM B61, rated for 1375 kPa (200 psi) saturated steam, 2750 kPa (400 psi) WOG, bronze disc, threaded ends, regrinding disc.
  - e. Type 405: Lift-type, forged steel body ASTM A105, rated for 2050 kPa at 216 deg C 300 psi at 420 deg F) minimum (Class 4130 kPa (600 psi) or 5500 kPa (800 psi)), hardened stainless steel disc, hard faced seat, bolted cover, threaded ends.
  - f. Type 406: Swing-type, Type 316 stainless steel body, disc and hanger, rated for 1725 kPa at 182 deg C 250 psi at 360 deg F) minimum.
  - g. Type 407: Silent spring-loaded wafer type, cast iron body ASTM A48 or A126 Class B, rated for 850 kPa (125 psi) water, 121 deg C 250 deg F)
  - h. Type 408: Silent spring-loaded wafer type, cast steel ASTM A216 WCB or cast iron ASTM A48 or A126 body, rated for 2050 kPa (300 psi) water, 121 deg C 250 deg F) stainless steel trim.
5. Ball Valves: Reduced port permitted for bypass (throttling) service; full port required for all other services, one-fourth turn to open.
  - a. Type 501: Type 316 stainless steel body, ball and stem, rated for 4130 kPa at 93 deg C (600 psi at 200 deg F) reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.
  - b. Fire safe design tested per APJ 607. Use for natural gas, and ASTM A351, Type 316SS, 600 lb. class standard port, socket weld ends, filled TFE seats, fire safe design for lube oil application.
  - c. Type 503: Carbon steel or ASTM B61 bronze body, steam service, rated for 1380 kPa at 200 deg C 200 psi at 390 deg F) stainless

steel ball and stem, Polyfil seat, live-loaded or adjustable stem seal, threaded ends.

- d. Type 504: Carbon steel or ASTM A536 ductile iron body, saturated steam service, rated for 1030 kPa (150 psi), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, ASME flanged ends.

6. Butterfly Valves:

- a. Type 601: Ductile iron body ASTM A395 or A536, wafer style, rated for 850 kPa at 120 deg C 125 psi at 250 deg F) bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, lever operator.
- b. Type 602: Carbon steel body, triple-offset design, lug or flanged type, rated for steam service at 1025 kPa at 260 deg C 150 psi at 500 deg F) stainless steel nitrided disc, stainless steel seat, stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.
- c. Vent Cocks:
- d. Type 701: Bronze body, tee handle, rated for 205 kPa at 38 deg C (30 psi at 100 deg F), ground plug, rated for tight shut-off on low pressure natural gas service.

C. HRSG Valves:

1. Steam Non-Return Stop Check Valves:

- a. Type: Straight-way Y-pattern, with dash-pot and piston and tapped drain openings, OS&Y, bolted bonnet, rising stem. Provide angle pattern only if shown on the contract drawings.
- b. Construction: Cast steel body ASTM A216 WCB, rated for 2050 kPa (300 psi) saturated steam, stellite faced steel disc, alloy steel seat, 2050 kPa (300 psi) ASME flanged ends.
- c. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering.

2. Stop Valves for Soot Blower, Steam Vents on Boiler Drums and Steam Lead, Steam Pressure Gage:

- a. Installation of steam pressure gage shut-off valves shall conform to ASME Boiler and Pressure Vessel Code, Section I.
- b. Soot blower angle stop valves (water tube boilers), OS&Y, chain operated, cast or forged steel, 1375 kPa (200 psi) steam rating, renewable seat and disc.
- c. Gate valves, two inches and under: Type 105.

3. Valves in Drain Lines from Steam Stop-Check Valve, Water Column, Gage Glass, Low Water Cut-offs, Soot Blower:

- a. Gate valves, two inches and under: Type 105.
- b. Check valves, two inches and under: Type 405.

4. Bottom Blowoff Valves:

- a. Type: Seatless, sliding plunger, OS&Y, designed for blowoff service. Sliding disc-type or globe-type valves are not permitted.



- b. Construction: ASTM A216 WCB cast steel body, rated for 2050 kPa (300 psi) saturated steam, 2050 kPa (300 psi) ANSI flanged ends. Valves shall have handwheel with rotating handle.
  - c. Conform to ASME B31.1.
- D. Steam above 100 kPa (15 psi), all valves in steam pressure reducing stations:
  - 1. Gate valves, 50 mm (2 inches) and under: Type 105.
  - 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.
  - 3. Globe valves, 50 mm (2 inches) and under: Type 205.
  - 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
  - 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  - 6. Ball valves, 50 mm (2 inches) and under: Type 503.
  - 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- E. Steam 100 kPa (15 psi) and under:
  - 1. Gate Valves, 50 mm (2 inches) and under: Type 104.
  - 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  - 3. Globe valves, 50 mm (2 inches) and under: Type 204.
  - 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
  - 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
  - 6. Ball valves, 50 mm (2 inches) and under: Type 503.
  - 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- F. Boiler Feedwater from Pumps to Boilers, Recirculation:
  - 1. Gate valves, 50 mm (2 inches) and under: Type 105.
  - 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 102.
  - 3. Globe valves, 50 mm (2 inches) and under: Type 204 or 205.
  - 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 202.
  - 5. Check valves, at boiler feed pump discharge: Type 408.
  - 6. Check valves, at boiler, 50 mm (2 inches) and under: Type 405.
  - 7. Check valves, at boiler, 65 mm (2-1/2 inches) and above: Type 402.
- G. Condensate, Condensate Transfer, Boiler Feedwater from Feedwater Deaerator to Boiler Feed Pump Suction, Overflow, Control and Instrument Piping for Condensate Storage Tank and for Feedwater Deaerator:
  - 1. Gate valves, 50 mm (2 inches) and under: Type 104.
  - 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
  - 3. Globe valves, 50 mm (2 inches) and under: Type 204.
  - 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 203.
  - 5. Butterfly valves, 65 mm (2-1/2 inches) and above Type 601.

6. Ball valves, 50 mm (2 inches) and under: Type 502.
  7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
  8. Check valves 50 mm (2 inches) and under: Type 404.
  9. Check valves, 65 mm (2-1/2) inches and above: Type 403.
  10. Check valves on pump discharge, all sizes: Type 407.
- H. Boiler Water Sampling, Continuous Blowdown:
1. Gate Valves, 50 mm (2 inches) and under: Type 104.
  2. Globe valves, 50 mm (2 inches) and under: Type 204.
  3. Check valves, 50 mm (2 inches) and under: Type 404.
  4. Ball valves, 50 mm (2 inches) and under: Type 502.
- I. Feedwater Sampling:
1. Ball valves, 50 mm (2 inches) and under: Type 501.
  2. Check valves, 50 mm (2 inches) and under: Type 406.
- J. Chemical Feed System (including inlet and drain valves on shot type chemical feeders):
1. Ball valves, 50 mm (2 inches) and under: Type 501.
  2. Check valves, 50 mm (2 inches) and under: Type 406.
- K. High Pressure Fuel Gas and Lube Oil:.
1. Ball Valves, all sizes: Type 501.
- L. Low Pressure Fuel Gas:
1. Valves: Type 301.
  2. Ball valves, 50 mm (2 inches) and under: Type 502. May be applied where plug valves are shown.
  3. Plug valves, 125 mm (5 inches) and above: Type 302.
  4. Plug valves, three-way, all sizes: Type 302.
  5. Check valves, 50 mm (2 inches) and under: Type 404.
  6. Vent cocks, 15 mm (1/2 inch) and under: Type 701.
- M. Compressed Air:
1. Gate valves, 50 mm (2 inches) and under: Type 104.
  2. Ball valves, 50 mm (2 inches) and under: Type 502.
- N. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- O. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- P. Instrumentation and Control Piping:
1. Ball valves, 50 mm (2 inches) and under: Type 502.

Q. Non-HRSG Blowdowns, Drains, Flow Sensing Lines:

1. Gate valves, 50 mm (2 inches) and under: Type 104.
2. Ball valves, 50 mm (2 inches) and under: Type 503

**2.16 SIGHTFLOW INDICATORS:**

- A. Provide, where shown, to allow observation of flow in piping systems.
- B. Type: In line, dual portholes on opposite sides, with safety shield, with or without rotor as shown on the drawings. Where provided, rotor shall have minimum of three vanes.
- C. Construction: Cast iron or bronze body, tempered borosilicate window, PTFE seals (except Buna-N on oil service), threaded ends on pipe sizes under 65 mm (2-1/2 inches), flanged ends on sizes 65 mm (2-1/2 inches) and above. Pressure and temperature ratings shall be equivalent to requirements for valves on the same pipelines.
- D. Safety Shield: Transparent wrap-around overlap covering entire sightflow indicator, designed to protect personnel from failure of indicator. Shield shall fit the indicator tightly and be suitable for 1030 kPa, 150 deg C (150 psi, 300 deg F).

**2.17 QUICK-COUPLE HOSE CONNECTORS AND STEAM HOSES:**

- A. Provide on all Y-strainer drains and where shown to allow quick connection of length of hose to piping drain or blowoff so that discharge fluid (water or steam) can be conveyed to a drainage system.
- B. Type: Straight through, plug and socket, screw type or cam locking connections, all units 20 mm (3/4-inch) pipe size. Integral shut-off devices not required.
- C. Service: Design for water and steam at 100 kPa (15 psi), 154 deg C 310 deg F)
- D. Spare Parts: Furnish one socket and one plug.
- E. Accessories: Furnish two hoses 6 m (20 feet) long, 20 mm (3/4-inch) inside diameter, rated for steam service at 690 kPa, 149 deg C 100 psi, 300 deg F) Hose must be sufficiently flexible to be placed in 1200 mm (4 foot) diameter coil. Provide connector on one end of each hose to mate with connectors on drains. Provide hose rack for holding both hoses. Securely mount rack in location selected by Resident Engineer.

**2.18 SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES AND ACCESSORIES:**

- A. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure. All valves shall comply with ASME Boiler and Pressure Vessel Code (Section I and VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
- B. HRSG Service: Section 23 52 35, HEAT RECOVERY STEAM GENERATOR.

- C. Steam Service (Pressure Vessels and Piping Systems): Refer to schedules on drawings for set pressures and capacities. Provide lifting levers, stainless steel trim, lapped seats on cast iron valves, EPDM o-rings on bronze valves.
- D. Compressed Air Service: Refer to Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT.
- E. Drip Pan Ells: Cast iron factory-built safety valve discharge fitting with pipe-within-pipe slip-type connection to vertical vent pipe, basin for collecting condensate from vent pipe, drain connections on basin and at base of ell.

## **2.19 STEAM PRESSURE REDUCING VALVES**

- A. Type: Single-seated, diaphragm operated, spring-loaded, steam pilot-controlled, normally closed, packless, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
- B. Service: Provide controlled reduced pressure to steam piping systems. Design for saturated steam at pressures shown on drawings or equipment requirements.
- C. Performance: Pressure control shall be smooth, continuous. Maximum 10 percent deviation from set pressure over an 18/1 turndown. Refer to schedules on drawings for flow and pressure requirements. Maximum flow capability of each valve shall not exceed capacity of downstream safety valves.
- D. Construction:
  - 1. Main Valve: Cast iron body rated for 1725 kPa (250 psi), threaded ends, for pipe sizes 50 mm (2 inches) and under. Cast steel body rated for 1025 kPa (150 psi) ASME flanged ends, or cast iron body 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Valve plug and seat shall be replaceable, Type 316 stainless steel or Monel. Stainless steel stem.
  - 2. Pilot Valve: Valve plug and seat shall be replaceable, stainless steel or Monel.
- E. Direct Digital Control Valves: May be furnished in lieu of steam operation. All specification requirements for steam operated valves shall apply. Valves shall be normally closed.
- F. Pneumatically-Controlled Valves: May be furnished in lieu of steam operation. All specification requirements for steam-operated valves apply. Valves shall close on failure of air supply.
- G. Sound Levels: Refer to requirements in Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.

## **2.20 STRAINERS, SIMPLEX BASKET TYPE**

- A. Provide on condensate lines where shown. Refer to Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT, for duplex basket strainers at oil pumps.
- B. Type: Simplex cylindrical basket type, clamp cover, closed-bottom, removable basket, drain at bottom with threaded plug.
- C. Service: Water at 100 deg C 212 deg F) 100 kPa (15 psi) maximum pressure.
- D. Construction:
  - 1. Body: Cast iron rated for 850 kPa (125 psi) ASME flanged ends, flow arrows cast on side.
  - 2. Basket: Stainless steel, 3 mm (0.125-inch) perforations. Ratio of screen open area to cross section of pipe; four to one minimum.

## **2.21 STRAINERS, Y-TYPE**

- A. Provide as shown on steam, water and compressed air piping systems.
- B. Type: Open-end removable cylindrical screen. Threaded blow-off connection.
- C. Construction:
  - 1. Steam Service 420 to 1025 kPa (61 to 150 psi): Cast steel rated for 1025 kPa (150 psi) saturated steam with 1025 kPa (150 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, rated for saturated steam at 1025 kPa (150 psi) threaded ends, for pipe sizes 50 mm (2 inches) and under.
  - 2. Steam Service 415 kPa (60 psi) and under, water (except boiler feed between feedwater pumps and boilers), compressed air: Cast iron rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, with 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 850 kPa (125 psi) saturated steam, 1200 kPa (175 psi) WOG, for pipe sizes 50 mm (2 inches) and under.
  - 3. Boiler Feed between Feedwater Pumps and Boilers: Cast steel rated for 1725 kPa at 232 deg C 250 psi at 450 deg F) with 2050 kPa (300 psi) ASME flanged ends, or cast iron with 1725 kPa (250 psi) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast iron or bronze, threaded ends, rated for 1725 kPa at 232 deg F (250 psi at 450 deg F) for pipe sizes 50 mm (2 inches) and under.
- D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. For strainers 80 mm (3 inch) pipe size and smaller, diameter of openings shall be 0.8 mm (0.033 inch) or less on steam service, 1.3 mm (0.05 inch) or less on water service, 0.3 mm (0.01-inch) or less on compressed air service. For strainers 100 mm (4 inch) pipe size and greater, diameter of openings shall be 1.3 mm (0.05 inch) on steam service, 3 mm (0.125 inch) on water service. Provide 80 mesh stainless steel screen liner on all strainers installed upstream of water meters or control valves.

- E. Accessories: Gate or ball valve and quick-couple hose connection on all blowoff connections. These items are specified elsewhere in this section.

## **2.22 EMERGENCY GAS SAFETY SHUT-OFF VALVE WITH EARTHQUAKE SENSOR:**

- A. Permits remote shut-off of fuel gas flow to co-generation plant.
- B. Type: Manually opened, electrically held open, automatic closing upon power interruption. Pneumatic operator is not permitted.
- C. Performance: Shall shut bubble tight within one second after power interruption. Refer to the drawings for pressure, flow, and valve size requirements.
- D. Service: Natural gas.
- E. Construction: UL listed, FM approved, rated for 850 kPa (125 psi) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. Cast iron, cast steel or bronze body, open and shut indicator. Valves for LP gas service shall be rated at 1725 kPa (250 psi).
- F. Control Switch: Mounted in Control Room. Provide auxiliary switch to operate annunciator on Co-generation Plant Instrumentation Panel.
- G. Earthquake Sensor: Mechanical device which automatically breaks 120 volt electrical circuit to safety shut off valve when earthquake occurs allowing valve to automatically close. UL listed and shall comply with State of California Standard Codes (Part 12 Title 24 CAC). Valve shall close within 5 seconds after sensor is subjected to horizontal sinusoidal oscillation having a peak acceleration of 2.94 m/sec<sup>2</sup> (0.3g) and a period of 0.4 seconds. The valve shall not shut off when the sensor is subjected for 5 seconds to horizontal, sinusoidal oscillations having: a peak acceleration of 3.92 m/sec<sup>2</sup> (0.4g) with a period of 0.1 second; a peak acceleration of 0.78 m/sec<sup>2</sup> (0.08g) with a period of 0.4 second; peak acceleration of 0.78 m/sec<sup>2</sup> (0.08g) with a period of 1.0 second. Sensor shall be corrosion-resistant for outside location.

## **2.23 STEAM TRAPS**

- A. Application: Steam line drip points and heat exchangers. Each type furnished by a single manufacturer.
- B. Type: Inverted bucket type with thermostatic vent in bucket except closed float-thermostatic on discharge side of pressure reducing stations and on all heat exchangers. Refer to the drawings for trap locations, capacity and size, differential operating pressures, and design pressure.
- C. Bodies: Cast iron or stainless steel. Construction shall permit ease of removal and servicing working parts without disturbing connected piping.
- D. Floats: Stainless steel.
- E. Valves: Hardened chrome-steel.

- F. Mechanism and Thermostatic Elements: Stainless steel mechanisms. Bimetallic strip air vent on inverted bucket traps.
- G. Provision for Future Trap Monitoring System: All traps shall include ports for future installation of monitoring devices. Ports shall be plugged. To facilitate future removal of the plugs, install them with Teflon tape on the threads.
- H. Identification: Label each trap at the factory with an identification number keyed to number that is shown on the drawings. Label shall be a metal tag permanently affixed to the trap.
- I. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, trap monitoring device or ports for future monitoring device, and valved test ports, provide factory-packaged trap station including these features.

## **2.24 FLEXIBLE CONNECTORS**

- A. Provide flexible connectors as shown to allow differential movements of pumps and piping systems subject to thermal expansion, to serve as vibration isolators between air compressors and piping systems, and to allow connection of steam or compressed air atomizing media for oil burners on water tube boilers.
- B. Units for Water Service
  - 1. Service: Refer to schematic diagrams for pressure, temperature and movement requirements. If requirements are not shown on the drawings, units shall be designed for maximum system pressure, temperature, axial movement and lateral movement.
  - 2. Construction
    - a. Teflon Bellows Type: Molded Teflon bellows with metal reinforcing rings, flanged ends, bolted limit rods.
    - b. Stainless Steel Bellows Type: Multi-ply stainless steel with flanged ends, bolted limit rods.
    - c. Flexible Metal Hose Type: Corrugated stainless steel or bronze hose wrapped with wire braid sheath. Ends shall be threaded, with union connectors, for pipe sizes 50 mm (2 inches) and below, flanged for pipe sizes 65 mm (2-1/2 inches) and greater.
- C. Units for Compressed Air Service Only:
  - 1. Service: Designed for 93 deg C 200 deg F) 1025 kPa (150 psi), 13 mm (1/2-inch) intermittent offset.
  - 2. Construction. Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.
- D. Units for Atomizing Media Service (Steam, Compressed Air) and Steam Safety Valve Drip Pan Ell Drains:
  - 1. Service: Designed for saturated steam at set pressure of boiler safety valves or for set pressure of compressor relief valve, whichever is

greater. Hose shall be designed for bend radii to suit location of connection points to burner piping system. Hose shall also be designed for intermittent flexing.

2. Construction: Flexible corrugated stainless steel or bronze hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

## **2.25 PIPING SUPPORT SYSTEMS**

- A. Provide an engineered piping support system with all hangers, supports and anchors designed and located by experienced technical pipe support specialists, utilizing piping system design and analysis software. The system design must be completely documented and submitted for review.
- B. All pipe hangers and supports, and selection and installation shall comply with MSS SP-58, SP-69, SP-89, SP-90, SP-127.
- C. All pipe hanger and support devices must be in compliance with specified MSS SP-58 type numbers, have published load ratings, and be products of engineered pipe support manufacturers.
- D. All pipe stresses and forces and moments on connecting equipment and structures shall be within the allowances of the ASME B31.1 code, applicable building codes, and equipment manufacturer's design limits.
- E. Piping that expands and contracts horizontally including steam, steam condensate, boiler feed, condensate transfer, shall be supported by roller or sliding type hangers and supports except when long vertical hanger rods permit sufficient horizontal movement with the vertical angles of the rods less than 4 degrees.
- F. Piping that expands and contracts vertically including steam, steam condensate, boiler feed, condensate transfer, shall be supported by engineered variable spring and spring cushion hangers. Utilize MSS SP-69 selection requirements and guidelines. Vibration isolator hanger types are not permitted.
- G. Seismic braces and shock absorbers shall be provided. Comply with MSS SP-127 design requirements and guidelines. Piping shall remain fully connected and supported under the design seismic events. Piping and connected equipment shall not be overstressed beyond code limits during seismic events.
- H. Piping system anchors shall be engineered and located to control movement of piping that is subject to thermal expansion.
- I. Prior to construction, submit complete engineering calculation methods and results, descriptions of all devices with MSS numbers, sizes, load capabilities and locations. Submit calculations on all moments and forces at anchors and guides, all hanger loads, all pipe stresses that are within 20 percent of the code allowable or exceed the ASME B31.1 code allowable, all pipe movements at supports.



J. Detailed Design Requirements:

1. Piping system design and analysis software shall be current state of the art that performs B31.1 Code analyses, and shall be utilized to analyze pipe movement and deflection, pipe stresses, pipe support forces and moments, and for selection of pipe support types and sizes. Seismic restraint calculations shall utilize the applicable shock spectra for the type of building structure, type of supported system, and the locality. Comply with MSS SP-127.
2. Each support for piping 60 mm (2-1/2 inches) and above shall be completely engineered to include location, type and size, hot and cold loads and movement. Submit layout drawings showing precise support locations and submit individual drawings for each support assembly showing all components, sizes, loadings.
3. Supports for piping 50 mm (2 inches) and below shall be engineered in general terms with approximate locations, typical support types and sizes, approximate movements. Submit layout drawings showing general locations and support types and sizes.
4. Obtain permissible loadings (forces and moments) for equipment nozzles (pipe connections) from the manufacturer of the boilers, the feedwater deaerator and any other equipment as necessary. Professional structural engineer shall verify capability of building structure to handle piping loads.
5. The project drawings may not show locations and types of resilient supports including rollers and springs, or special supports including anchors, guides and braces. Contractor shall confirm support location and design based on the requirements herein.
6. Variable spring hangers conforming the MSS SP-58, Type 51, shall support all piping that expands vertically from thermal effects which may include connected equipment, such as boilers. Spring rates must be selected to avoid excessive load transfer to the connected equipment as the piping expands vertically. Vibration-type spring isolators are not acceptable. Light duty spring hangers, MSS SP-58, Type 48, may be utilized on loads of 90 kg (200 lb) or less, and vertical movement of 3 mm (0.125 inches) or less. Spring cushion hangers, MSS SP-58, Type 49, may be utilized for vertical movement of 3 mm (0.125 inches) or less.
7. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
8. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost to the Government.

K. Hangers and Supports - Products:

1. Factory-built products of a manufacturer specializing in engineered pipe supports. All components must have published load ratings. All spring type supports shall have published spring rates and movement limits. All support assemblies shall include threaded connections that permit vertical position adjustment. Supports shall comply with MSS SP-58 Type Numbers as listed below.

2. Upper Attachments to Building Structure: Types 18, 20, 21, 22, 23, 29, and 30.
3. Roller Supports: Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
4. Variable Spring Hanger Assembly:
  - a. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
  - b. Typical features of variable spring hangers include spring rates under 150 lb/in, enclosed spring, load and travel indicator, sizes available with load capabilities ranging from 50 lb to multiples of 10,000 lb.
5. Spring Cushion Hanger Assembly: Double Rod: Type 41 and 49.
6. Light Duty Spring Hanger Assembly: Type 48 light duty spring, with Type 3 pipe clamp or Type 1 clevis. Locate Type 48 light duty spring within 300 mm (1 foot) above pipe attachment.
7. Clevis Hangers: Type 1.
8. Wall Brackets: Type 31, 32, and 33.
9. Pipe Stands: Type 38.
10. Riser Clamps: Type 42.
11. Roller Guides: Type 44. Construct guides to restrain movement perpendicular to the long axis of the piping. All members shall be welded steel.
12. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with U-bolts.
13. Pipe Covering Protection Saddles: Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided. Insulation shields are not permitted. Refer to Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION.
14. Sliding Supports: Type 35. Welded steel attachments to pipe and building structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
15. Piping Anchors: Provide engineered designs to accommodate the calculated loads.
16. Seismic Restraints:
  - a. Comply with MSS SP-127.
  - b. Bracing: Provide as determined by engineering calculations.
  - c. Shock Absorbers: Type 50. Mechanical or hydraulic type rated for shock loads. Pipe attachments shall be Type 3.

## **2.26 PIPE AND VALVE FLANGE GASKETS**

- A. Non-asbestos, designed for the service conditions. On steam service utilize 3 mm (1/8 inch) thick Class 300 spiral-wound with Type 304 stainless steel and mica/graphite filler and carbon steel gauge ring.
- B. For natural gas service, utilize spiral wound 304SS/PTFE with 304 stainless steel inner ring. ASME B16.20.

## **2.27 THREAD SEALANTS:**

- A. As recommended by the sealant manufacturer for the service.

## **2.28 PIPE SLEEVES:**

- A. Service: For pipes passing through floors, walls, partitions.
- B. Construction: Steel pipe, schedule 10 minimum.
- C. Sleeve Diameter: Not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe and thermal insulation, vapor barrier, and protective covering for insulated pipe; sleeves for un-insulated pipe shall be not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe.

# **PART 3 - EXECUTION**

## **3.1 ARRANGEMENT OF PIPING**

- A. The piping arrangement shown is a design based on currently available equipment. The plans show typical equipment to scale and show practical arrangement. Modification will be necessary during construction, at no additional cost to the Government, to adapt the equipment layout and piping plans to the precise equipment purchased by the Contractor. Accessibility for operation and maintenance must be maintained.
- B. All piping shall be installed parallel to walls and column centerlines (unless shown otherwise). Fully coordinate work of each trade to provide the designed systems without interference between systems. All piping shall be accurately cut, true, and beveled for welding. Threaded piping shall be accurately cut, reamed and threaded with sharp dies. Copper piping work shall be performed in accordance with best practices requiring accurately cut clean joints and soldering in accordance with the recommended practices for the material and solder employed.
- C. All piping shall be pitched for drainage at a constant slope of 25 mm in 12 m (1 inch in 40 feet). Steam, condensate, trap discharge, drip, drain, air, gas and blowdown piping shall pitch down in direction of flow. Service water, pumped condensate, pumped boiler feedwater, oil, shall pitch up in direction of flow. Provide valved air vents at top of rise and valved drains at low points. Gas piping may be run level as it is presumed to be dry, but dirt pockets shall be provided at base of risers.

- D. Valves shall be located and stems oriented to permit proper and easy operation and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be below centerline of pipe. Refer to plans for stem orientation. Where valves are more than 2100 mm (7 feet) above the floor or platform, stems shall be horizontal unless shown otherwise. Gate and globe valves more than 3 m (10 feet) above floor or platform, shall have chain wheel and chain for operation from floor or platform. Provide hammer-blow wheel on any valve that cannot be opened or tightly closed by one person. Steam line gate and butterfly type isolation valves 750 mm (3 inch) pipe size and above shall have factory or field-fabricated 20 mm or 25 mm (3/4 or one inch) globe-valved warm-up bypasses if the steam line length is 6 m (20 feet) or longer.
- E. Provide union adjacent to all threaded end valves.
- F. Bolt wafer-type butterfly valves between pipe flanges.
- G. Provide valves as necessary to permit maintenance of a device or sub-system without discontinuing service to other elements of that service or system.
- H. Do not install any piping within 600 mm (2 feet) of water tube boiler side or top casings.

### **3.2 WELDING**

- A. The contractor is entirely responsible for the quality of the welding and shall:
  - 1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
  - 2. Comply with ASME B31.1 and AWS B2.1.
  - 3. Perform all welding operations required for construction and installation of the piping systems.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, and AWS B2.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the Resident Engineer (RE), to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the RE with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.

- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Utilize split welding rings or approved alternate method for joints on all pipes above 50 mm (two-inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (one foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).
- H. Non-Destructive Examination of Piping Welds:
  - 1. The RE may require up to ten percent of the welded piping joints to be examined using radiographic testing. If defective welds are discovered the RE may require examination of all pipe joint welds.
  - 2. An approved independent testing firm regularly engaged in radiographic testing shall perform the radiographic examination of pipe joint welds. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.
  - 3. Comply with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project. The RE/COTR reserves the right to review all inspection records.
- I. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.
- J. Electrodes: Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

### **3.3 PIPING JOINTS**

- A. All butt-welded piping shall be welded at circumferential joints, flanges shall be weld neck type; slip-on flanges, screwed flanges may be applied only with written approval of the RE.
- B. Companion flanges at equipment or valves shall match flange construction of equipment or valve. Raised face shall be removed at all companion flanges when attached to flanges equipped for flat face construction.
- C. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains

shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

- D. Screw threads shall be made up with Teflon tape except gas and oil piping joints shall utilize specified joint compound.
- E. Solder joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

### **3.4 BRANCH INTERSECTION CONNECTIONS**

- A. Factory-built reinforced tees and laterals are required.
- B. Factory-built integrally-reinforced forged steel branch outlet fittings may be used on reduced size connections upon approval of RE/COTR. They must comply with MSS-SP-97.

### **3.5 EXPANSION AND FLEXIBILITY**

- A. The design includes provision for piping expansion due to pressure, thermal, weight and seismic (where applicable) effects. It is the Contractor's responsibility to avoid reduction in flexibility and increase in stress in piping systems. Major deviation will be shown by submittal for review of scale working drawings and stress calculations for the piping systems. Contractor shall provide any necessary additional construction and materials to limit stresses to safe values as directed by the RE and at no additional cost to the Government.

### **3.6 PIPE BENDING**

- A. Pipe bending shall be in accordance with the recommended practices of PFI ES24. Only ASTM A106 seamless pipe may be bent. Sizes below 50 mm (2 inches) may be bent in field; sizes 65 mm (2-1/2 inches) and larger shall have factory fabricated bends. Minimum radii and tangent lengths for field bent piping are shown in the following table:

Size	Minimum Radius	Minimum Tangent
1/2 inch	2-1/2 inches	1-1/2 inches
3/4 inch	2-3/4 inches	1-3/4 inches
1-inch	5-inches	2-inches
1-1/4 inches	6-1/4 inches	2-inches
1-1/2 inches	7-1/2 inches	2-1/2 inches

### **3.7 SIZE CHANGES**

- A. Piping size changes shall be accomplished by use of line reducers, reducing ell, reducing tee. Apply eccentric reduction in all piping requiring continuous drainage; steam, condensate, vacuum, blowdown. Concentric reduction may be applied in run of piping involving pressure water systems

except at pump inlets. Use concentric increasers where flow is in direction of increased size. Eccentric reduction, top flat, at all pump connections.

### **3.8 ADDITIONAL DRIPS AND TRAPS**

- A. Where additional rises or drops in steam or gas lines are provided, provide additional drip pockets with steam trap assemblies on steam lines and additional dirt pockets on gas lines.

### **3.9 MINOR PIPING**

- A. Minor piping associated with instrumentation and control is generally not shown. Interconnection of sensors, transducers, control devices, instrumentation panels, combustion control panel, burner control panels is the responsibility of the contractor. Small piping associated with water cooling, drips, drains and other minor piping may not be shown to avoid confusion in the plan presentation but shall be provided as part of contract work.

### **3.10 DIELECTRIC CONNECTION**

- A. Where copper piping is connected to steel piping provide dielectric connections.

### **3.11 INSTALLATION - EXTERNAL STEAM PIPING FROM HRSG TO MAIN HEADER**

- A. From HRSG to Second Stop Valve: Fabricate from HRSG nozzle through second stop valve under the rules for HRSG external piping of the ASME Boiler and Pressure Vessel Code, Section I. Full compliance will be required, including qualification of welders, Code inspection, and certification with ASME Form P4A. Deliver original of Form P4A properly executed to RE.
- B. Construction shall include: non-return stop and check valve at the HRSG, welding coupling for 20 mm (3/4-inch) vent, second stop valve, steam flowmeter primary element, welding coupling for IPT calorimeter connection located to provide clear space and access for temporary test calorimeter, and header stop valve. Second stop valve may be deleted if the entire steam line from the non-return valve to the header valve is constructed in accordance with the rules for boiler external piping, ASME Section I.
- C. Companion flange at 2050 kPa (300 psi) valves shall be 2050 kPa (300 psi) weld neck; at 1025 kPa (150 psi) valves shall be 1025 kPa (150 psi) weld neck.
- D. Equip header stop valve with factory applied warm-up bypass connected to drilled and tapped bosses in valve body located above and below valve wedge. Connect valved drain to header valve body boss located above valve wedge.
- E. Equip steam pipe with 20 mm (3/4-inch) vent, 1375 kPa (200 psi) bronze gate valve, as specified.
- F. Support and slope boiler steam line to drain; apply variable spring hangers (MSS-SP58, Type 51 or 53).

- G. Provide screwed fitting for calorimeter (temporary test instrument) on side of pipe as shown. Allow 600 mm (2 feet) horizontal and vertical clearance for calorimeter.
- H. Handwheel and drain valve on non-return stop-check valve shall be within easy reach of boiler platform.
- I. Disassemble, clean and reassemble entire mechanism of non-return stop check valve after conclusion of boiler testing.

### **3.12 INSTALLATION - MAIN STEAM HEADER**

- A. The header shall be the connection point for steam piping from all boilers and for steam distribution piping. The boiler plant steam pressure control transmitter shall be connected to the header.
- B. Steam header shall be assembly of tees, pipe sections, and weld neck flanges.
- C. Factory-fabricated forged steel integrally reinforced branch outlet welding fittings, standard weight, ASTM A105 Grade 2, may be applied in lieu of tees for all branch outlets less than the full size of the header. Comply with fitting manufacturer's recommendations and requirements of ASME B31.1 and MSS-SP-97.
- D. Provide header supports and anchor as shown; apply insulation saddles for insulation thickness as required in Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.
- E. Weld neck flange bolt position shall conform to required valve, stem, and bypass orientation as shown.
- F. Header construction as specified, includes the entire header and branches to first valve.
- G. Anchor and guide header to resist thermal and weight forces and also seismic forces where required.
- H. All valves must be accessible without the use of ladders or chain-wheels.

### **3.13 INSTALLATION - HRSG BOTTOM BLOWOFF PIPING**

- A. Fabricate with long radius ells, Y-form laterals. Tees and crosses are not permitted.

### **3.14 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF**

- A. Provide drain line from connection on exhaust head to roof drain. Provide pipe size same as drain connection size.

### **3.15 INSTALLATION - SIGHT FLOW INDICATORS**

- A. Locate to permit view from floor or platform.



**3.16     INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES**

- A.     Provide sufficient clearance on all sides of valve to permit replacement of working parts without removing valve from pipeline.

**3.17     INSTALLATION - EMERGENCY GAS SAFETY SHUT-OFF VALVES AND EARTHQUAKE VALVES**

- A.     Locate so that valve position indicator is visible from nearest walkway.
- B.     Provide control wiring and wiring to annunciator on instrumentation panel and to computer workstation (if provided).

**3.18     INSTALLATION - FLEXIBLE CONNECTORS**

- A.     Install units for water and compressed air service in a straight run of pipe. Units for atomizing media service may be installed with bends if necessary. Designer of atomizing media piping must coordinate hose connection points with allowable bend radius of hose.

**3.19     INSTALLATION - SAFETY VALVES, RELIEF VALVES AND SAFETY-RELIEF VALVES**

- A.     Orient valves so that lifting levers are accessible from nearest walkway or access platform. Valves must be removable without requiring disassembling of vents, except where otherwise specifically provided.
- B.     Provide a drip pan elbow at discharge of each steam or economizer valve with slip joint in vent discharge line, arranged to prevent vent line from imposing any force on valve and to prevent any moisture accumulation in valve. Connected drip pan ell drains to drain piping to floor drain. Provide flexible connector on drain line, adjacent to drip pan ell.
- C.     Support vent line from above. Each steam valve must have separate vent line to atmosphere unless shown otherwise.

**3.20     INSTALLATION - Y-TYPE STRAINERS ON STEAM SERVICE**

- A.     Install with basket level with the steam pipe so that condensate is not trapped in the strainer.

**3.21     INSTALLATION - QUICK COUPLE HOSE CONNECTORS**

- A.     Install male plugs on each piping drain. Connect socket to one end of steam hose.

**3.22     INSTALLATION - VIBRATION ISOLATORS IN PIPING**

- A.     Install on all air lines and water supply lines to air compressors.
- B.     Also install on pump connections as shown.

### **3.23     INSTALLATION - PIPE SLEEVES**

- A.    Accurately locate and securely fasten sleeves to forms before concrete is poured; install in walls or partitions during the construction of the walls.
- B.    Sleeve ends shall be flush with finished faces of walls and partitions.
- C.    Pipe sleeves passing through floors shall project 25 mm (1 inch) minimum above the finished floor surface and the bottom of the sleeve shall be flush with the underside of the floor slab.

### **3.24     INSTALLATION - PIPE SUPPORT SYSTEMS**

- A.    Coordinate support locations with building structure prior to erection of piping. Also refer to approved shop drawings of equipment and approved piping layout and hanger layout drawings when locating hangers. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site.
- B.    Upper attachments to Building Structure:
  - 1.    New Reinforced Concrete Construction: Concrete inserts.
  - 2.    Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles (or other construction shown on the drawings) which are expansion-bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
  - 3.    Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.
- C.    Expansion Fasteners and Power Set Fasteners: In existing concrete floor, ceiling and wall construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D.    Special Supports:
  - 1.    Secure horizontal pipes where necessary to prevent vibration or excess sway.
  - 2.    Where hangers cannot be adequately secured as specified, (for example, support for flow metering sensing lines, pneumatic tubing, control piping) special provisions shall be made for hanging and supporting pipe as directed by the RE.
  - 3.    Pipe supports, hangers, clamps or anchors shall not be attached to equipment unless specifically permitted by the specifications for that equipment or unless RE gives written permission. No attachments to boiler casings permitted.

- E. Spring Hangers: Locate spring units within one foot of the pipe, breeching or stack attachment except in locations where spring assemblies interfere with pipe insulation. Adjust springs to loads calculated by hanger manufacturer.
- F. Seismic Braces and Restraints: Do not insulate piping within one foot of device until device has been inspected by RE.

### **3.25 CLEANING OF PIPING AFTER INSTALLATION**

- A. Flush all piping sufficiently to remove all dirt and debris. Fill piping completely. Velocity shall be equivalent to that experienced during normal plant operation at maximum loads. During flushing, all control valves, steam traps and pumps must be disconnected from the system. After cleaning is complete, remove, clean and replace all strainer baskets and elements. Reconnect all equipment. Provide safe points of discharge for debris blown from pipes.

### **3.26 TESTING**

- A. Testing of piping components is not required prior to installation. Valves and fittings shall be capable of withstanding hydrostatic shell test equal to twice the primary design service pressure except as modified by specifications on fittings, ASME B16.5. This test capability is a statement of quality of material. Tests of individual items of pipe, fittings or equipment will be required only on instruction of RE and at Government cost.
- B. After erection, all piping systems shall be capable of withstanding a hydrostatic test pressure of 1.5 times design pressure, as stipulated in ASME B31.1. Hydrostatic tests will be required only on boiler external steam piping, utilizing water as the test medium. Hydrostatic tests will be required on other piping when operating tests described are unsatisfactory, or when inspection of welds shows poor workmanship and is subject to question by the RE. When hydrostatic tests show leaks, the RE will require necessary welding repairs, in accordance with ASME B31.1, at the Contractor's cost.
- C. Perform operating test as follows:
  - 1. All steam piping prior to insulation shall be subjected to steam at final operating pressure. Inspect all joints for leaks and workmanship. Corrections shall be made as specified.
  - 2. Test main gas piping with compressed air at twice the service pressure entering VA property from utility service. Test interior, high pressure gas piping to 1.5 times the design pressure for at least 1/2 hour after all leaks have been located and stopped. Test joints with soap solution, check thoroughly for leaks.
  - 3. Test boiler feedwater, condensate, vacuum and service water systems under service conditions and prove tight.
  - 4. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.

5. Make corrections and retests to establish systems that have no leaks. Replace or recut any defective fittings or defective threads. Soldered material shall be thoroughly cleaned prior to resoldering. Back welding of threads will not be permitted.
- D. Hydrostatically test boiler external steam piping from HRSG to header in approved manner with water of same time boiler is hydrostatically tested under the supervision of RE. Prior to hydrostatic test, remove all valves not rated for hydrostatic test pressure. Replace valves after tests are satisfactorily completed. Hydrostatic test pressure shall be 1.5 times design pressure and performed in accordance with ASME Boiler and Pressure Vessel Code, Section I.
- E. Generally, insulation work should not be performed prior to testing of piping. Contractor may, at own option and hazard, insulate piping prior to test, but any damaged insulation shall be replaced with new quality as specified for original installation at Contractor's cost and time.
- F. Safety, Safety-Relief, Relief Valves: After installation, test under pressure in presence of RE/COTR. Test operation, including set pressure, flow, and blowdown in accordance with ASME Boiler and Pressure Vessel Code. Any deficiencies must be corrected and retest performed. Refer to Section 23 52 35, HEAT RECOVERY STEAM GENERATOR for boiler safety valve test requirements.
- G. Gas Compressor testing: The following minimum tests shall be performed. Standard testing of the compressor package shall include but not be limited to:
  1. Compressor frame standard factory tests to verify performance Specification.
  2. All protection equipment and devices, safety devices, and remote functions shall be tested.
  3. All wiring shall be checked for continuity and insulation integrity.
  4. All assembled piping/headers will be checked for leaks using air/nitrogen pressure and a soap solution to check for leaks. All power, wire, test equipment, and personnel required for testing shall be supplied by Supplier.
  5. All test data shall be recorded and cosigned by Company's designated representative and Supplier.

### **3.27 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.28 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 23 21 13**

**HYDRONIC PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Chilled Water distribution piping in trenches, tunnels, and manholes (coordinate with Section 33 63 00, STEAM AND CHILLED WATER SITE DISTRIBUTION).
- B. Chilled water, heating water, condenser water piping, and hydronic system components inside buildings and outside buildings above grade.
- C. Water piping to connect HVAC equipment, including the following:
  - 1. Chilled water, condenser water, heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping.
- D. Underground chilled water to and from thermal storage tank and underground chilled water in and around Building 5.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklist, and training.
- F. Section 31 20 00, EARTH MOVING: Excavation and backfill.
- G. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- H. Section 33 10 00, WATER UTILITIES: Underground piping.
- I. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.
- J. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- K. Section 23 21 23, HYDRONIC PUMPS: Pumps.

- L. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION: Piping insulation.
- M. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: Boiler piping.
- N. Section 23 23 00, REFRIGERANT PIPING: Refrigerant piping and refrigerants.
- O. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.
- P. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM: Temperature and pressure sensors and valve operators.
- Q. Section 26 42 00, CATHODIC PROTECTION: Cathodic protection of Cased Piping Systems.
- R. Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION: Steam and chilled water distribution outside in tunnels, trenches and vaults and exterior direct buried piping.

### **1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.
- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
  - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Grooved joint couplings and fittings.
  - 6. Valves of all types.
  - 7. Strainers.



8. Flexible connectors for water service.
  9. Pipe alignment guides.
  10. Expansion joints.
  11. Expansion compensators.
  12. All specified hydronic system components.
  13. Water flow measuring devices.
  14. Gages.
  15. Thermometers and test wells.
  16. Seismic bracing details for piping.
- C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
1. Heat Exchangers (Water to Water).
  2. Air separators.
  3. Expansion tanks.
- D. Submit the welder's qualifications in the form of a current (less than one year old) and formal certificate.
- E. Seismic calculations, details, anchors and restraining devices required to meet requirements including supporting steel.
- F. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
  2. One complete set of reproducible drawings.
  3. One complete set of drawings in electronic Autocad and PDF formats.
- H. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute, Inc.
- American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):
1. B1.20.1-83(R2006) Pipe Threads, General Purpose (Inch)
  2. B16.4-06 Gray Iron Threaded Fittings B16.18-01 Cast Copper Alloy Solder joint Pressure fittings
  3. B40.100-05 Pressure Gauges and Gauge Attachments
- C. American Society of Mechanical Engineers (ASME):
1. B16.3-2006 Malleable Iron Threaded Fittings: Class 150 and 300
  2. B16.4-2006 Gray Iron Threaded Fittings: (Class 125 and 250)
  3. B16.5-2003 Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
  4. B16.9-07 Factory-Made Wrought Butt Welding Fittings
  5. B16.11-05 Forged Fittings, Socket-Welding and Threaded
  6. B16.18-01 Cast Copper Alloy Solder Joint Pressure Fittings
  7. B16.22-01 Wrought Copper and Bronze Solder-Joint Pressure Fittings
  8. B16.24-06 Cast Copper Alloy Pipe Flanges and Flanged Fittings
  9. B16.39-06 Malleable Iron Threaded Pipe Unions
  10. B16.42-06 Ductile Iron Pipe Flanges and Flanged Fittings
  11. B31.1-08 Power Piping
  12. B40.100-05 Pressure Gauges and Gauge Attachments
  13. Section VIII D1-07 Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels Division 1 -Basic Coverage
- D. American Society for Testing and Materials (ASTM):
1. A47/A47M-99 (2004) Ferritic Malleable Iron Castings
  2. A53/A53M-07 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  3. A106/A106M-08 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
  4. A126-04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
  5. A183-03 Standard Specification for Carbon Steel Track Bolts and Nuts

6. A216/A216M-08 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
  7. A307-04e01 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
  8. A449-07b e1 HEX Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 KSI Minimum Tensile Strength, General Use
  9. A536-84 (2004) Standard Specification for Ductile Iron Castings
  10. B62-02 Standard Specification for Composition Bronze or Ounce Metal Castings
  11. B88-03 Standard Specification for Seamless Copper Water Tube
  12. C591-08 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
  13. F439-06 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
  14. F441/F441M-02 Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- E. American Water Works Association (AWWA):
- F. American Welding Society (AWS):
1. B2.1-02 Standard Welding Procedure Specification
- G. Expansion Joint Manufacturer's Association, Inc. (EJMA):
1. EMJA-2003 Expansion Joint Manufacturer's Association Standards, Ninth Edition
- H. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
1. SP-67-02a Butterfly Valves
  2. SP-70-06 Gray Iron Gate Valves, Flanged and Threaded Ends
  3. SP-71-05 Gray Iron Swing Check Valves, Flanged and Threaded Ends
  - ?. SP-80-08 Bronze Gate, Globe, Angle and Check Valves
  4. SP-85-02 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
  5. SP-110-96 Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- I. Tubular Exchanger Manufacturers Association: TEMA 9th Edition, 2007

#### **1.6 SEISMIC REQUIREMENTS:**

- A. Seismic design is the responsibility of the Contractor and shall comply with the requirements of Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Fittings, anchors, guides and other piping supports called for on the drawings or specifications shall be assumed to be for general support or related to thermal expansion and shall not be

assumed to be usable for seismic duty. The Contractor shall provide for all design, detailing and construction material and labor required for a complete seismic resistance system for the chilled water piping within the trenches, tunnels and vaults as well as all chilled water, condenser water and hot water piping within the buildings, above or below grade, independent of restraints, anchors and supports shown. With the Resident Engineer's approval, the Contractor may request that components shown for general support and or thermal anchoring and guiding, be allowed as a component of the complete seismic restraining system pursuant to supporting calculations and approval by the project structural engineer of record.

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC

### **2.2 PIPE AND TUBING**

- A. Chilled Water, Condenser Water, Heating Hot Water, and Vent Piping:
  - 1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
- B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.
- C. Cooling Coil Condensate Drain Piping:
  - 1. From air handling units: Copper water tube, ASTM B88, Type M.
  - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.
- D. Chemical Feed Piping for Condenser Water Treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F441.
- E. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
  - 1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
  - 2. Forged steel, socket welding or threaded: ASME B16.11.
  - 3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
  - 4. Unions: ASME B16.39.
  - 5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.

- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor's option: Grooved mechanical couplings and fittings are optional.
  - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  - 2. Welding flanges and bolting: ASME B16.5:
    - a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
      - 1) Contractor's option: Convoluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
    - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
  - 3. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.
  - 4. Grooved Mechanical Pipe Couplings and Fittings: Contractor's Option): Grooved Mechanical Pipe Couplings and Fittings may be used, in accessible areas only, with cut or rolled grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.
    - a. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, A449 and ASTM A183.
    - b. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
    - c. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

## **2.4 FITTINGS FOR COPPER TUBING**

- A. Joints:
  - 1. Solder - Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping. .
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.
- C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

## **2.5 FITTINGS FOR PLASTIC PIPING**

- A. Chemical feed piping for condenser water treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F439.

## **2.6 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 99 degrees C (210 degrees F).
- E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.

## **2.7 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.1.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## **2.8 CASED PIPING SYSTEM (FOR UNDERGROUND CHILLED WATER BETWEEN THERMAL STORAGE TANK AND CHILLED WATER PLANT)**

- A. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.
- B. Carrier Pipe: Standard-weight, steel pipe and fittings.
- C. Carrier Pipe Insulation:
  - 1. Polyurethane Foam Pipe Insulation: Rigid, cellular, high-pressure injected between carrier pipe and jacket.
    - a. Comply with ASTM C 591; thermal conductivity (k-value) shall not exceed 0.14 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
    - b. 1" thickness.
- D. Casing: Filament-wound, fiberglass-reinforced polyester resin minimum thickness of 0.055 inches.
- E. Casing accessories include the following:
  - 1. Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.
  - 2. Expansion Blanket: Elastomeric foam, formed to fit over piping.
  - 3. End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.
- F. Source Quality Control: Factory test the carrier pipe to 150 percent of the operating pressure of system. Furnish test certificates.

## 2.9 VALVES

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2400 mm (8 feet) or more above the floor or operating platform.
- D. Shut-Off Valves:
  - 1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
  - 2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.
    - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
    - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
    - c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
      - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
      - 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
      - 3) Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):
        - a) 50 mm (2 inches) and smaller: MSS-SP 80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
        - b) 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.
- E. Globe and Angle Valves:

1. Globe Valves
    - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
    - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.
  2. Angle Valves:
    - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
    - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.
- F. Check Valves
1. Swing Check Valves:
    - a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
    - b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.
  2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
    - a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
    - b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
1. Ball or Globe style valve.
  2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
  3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
  2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof,



- self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
  4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.
- I. Pressure Sustaining Control Valve: Automatic, pilot controlled, pressure sustaining valve, activated by the pressure of the pipeline.
1. Pilot operated diaphragm valve designed to permit flow when upstream pressure is above the adjustable set point of the control pilot, and throttle toward closed when upstream pressure falls below the adjustable set point.
  2. The valve shall also act as a solenoid on-off control valve, opening to allow regulating control action or closing drip-tight as commanded by the solenoid pilot, and close drip-tight when downstream pressure becomes greater than upstream pressure.
  3. Include hydraulic check feature.
  4. Globe or angle pattern.
  5. Diaphragm constructed of nylon reinforced Buna-N, and shall not seal directly against the valve seat and shall be fully supported by the valve body and cover.
  6. Ductile iron, ASTM A536 main body and cover.
  7. Internal cast components shall be ductile iron or CF8M (316) stainless steel.
  8. All ductile components including body and cover shall be lined and coated with an NSF 61 Certified Epoxy coating.
  9. All main valve trim and throttling components shall be stainless steel.
  10. Pilot control systems shall contain an external Y-strainer, adjustable closing speed, (2) check valves, 2-way solenoid pilot, pressure sustaining pilot and isolation ball valves on all body connections.
  11. All pilot control systems shall utilize copper tubing and brass fittings.
  12. The adjustment range of the pressure relief/sustaining pilot shall be 20 - 200 psi.

**2.10 WATER FLOW MEASURING DEVICES (REFER TO SECTIONS 23 09 23 AND 25 10 10)**

**2.11 STRAINERS**

A. Basket or Y Type.

1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1

mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger:  
3.2 mm (0.125 inch) diameter perforations.

2. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

## **2.12 FLEXIBLE CONNECTORS FOR WATER SERVICE**

### **A. Flanged Spool Connector:**

1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
2. Working pressures and temperatures shall be as follows:
  - a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).
  - b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
3. Provide ductile iron retaining rings and control units.

### **B. Mechanical Pipe Couplings:**

1. See other fittings specified under Part 2, PRODUCTS.

## **2.13 FLEXIBLE EXPANSION LOOP (SEISMIC APPLICATIONS)**

- A. All equipment, either rigidly mounted or mounted on vibration isolators, shall be attached to the piping system using flexible loops designed for seismic movement. Flexible loops shall be capable of movement in the +X, +Y, and +Z planes and must completely isolate the equipment from the piping. System design flexible expansion loops shall be rated for 3" of seismic movement.
- B. All piping passing through building seismic joints shall contain a flexible expansion loop designed for seismic movement. Flexible loops shall be located at, or near the building seismic joint. A vertical support hanger, located within 4 pipe diameters, shall be installed on each side of the flexible loop. Each hanger to be transversely and longitudinally braced per local codes. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Flexible loops shall be capable of movement in the +X, +Y, and +Z planes. System engineer shall determine the required amount of seismic movement required by the Uniform Building Code and/or other applicable codes.
- C. Flexible expansion/seismic loops shall consist of two flexible sections of hose and braid, two 90f elbows, and a 180f return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180f return, and a drain/air release plug. Flexible loops shall impart no thrust loads to system support anchors or building structure. Flexible loops may be installed to

accommodate both thermal and seismic motion. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings, and compatible with gas or liquid conveyed by piping system. Movement capabilities and location, relative to seismic separation, shall be determined by system design engineer and manufacturers recommendations.

## **2.14 FLEXIBLE EXPANSION LOOP (THERMAL APPLICATIONS INSIDE BUILDING)**

- A. Flexible Expansion Loop (Thermal Applications Inside Buildings): Provide flexible expansion loops of size and type noted on drawings. Flexible loops shall consist of two flexible sections of hose and braid, two 90 degree elbows, and a 180 degree return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180 degree return, and a drain/air release plug. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application. For steam service, loops must be installed with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations. Materials of construction and end fittings type shall be consistent with pipe material and equipment/pipe connection fittings.

## **2.15 EXPANSION JOINTS**

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- C. Bellows - Externally Pressurized Type:
1. Multiple corrugations of Type 304 stainless steel.
  2. Internal and external guide integral with joint.
  3. Design for external pressurization of bellows to eliminate squirm.
  4. Flanged ends.
  5. Conform to the standards of EJMA and ASME B31.1.
  6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
  7. Integral external cover and internal sleeve.
- D. Where joints are required to accommodate both axial and lateral movement, provide appropriate system, such as self-equalizing, ring-controlled expansion joint for or metal corrugated style with control rods made of hydroformed T304 stainless steel, 150 psi pressure class for chilled water. As an alternate, universal, gimbal type joints shall be used.

- E. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, and date of manufacture..
- F. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.
- G. Supports: Provide saddle supports and frame or hangers for heat exchanger. Mounting height shall be adjusted to facilitate gravity return of steam condensate. Construct supports from steel, weld joints.

## **2.16 MANHOLES AND VAULTS**

- A. Refer to Section 33 63 00, STEAM AND CHILLED WATER SITE DISTRIBUTION.

## **2.17 HYDRONIC SYSTEM COMPONENTS**

- A. Plate and Frame Heat Exchanger:
  - 1. Fixed frame with bolted removable corrugated channel plate assembly, ASME code stamped for 150 psig working pressure.
  - 2. Corrugated channel plates shall be type 316 or 304 stainless steel.
  - 3. Channel plate ports to be double gasketed to prevent mixing or cross-contamination of hot side and cold side fluids. Gaskets to be EPPM.
  - 4. Channel plate carrying bars to be carbon steel with zinc yellow chromate finish.
  - 5. Fixed frame plates and moveable pressure plates to be corrosion resistant epoxy painted carbon steel.
  - 6. Piping connections 2" and smaller to be carbon steel NPT tappings. Piping connections 4" and larger to be stubbed port design to accept ANSI flange connections. Connection ports to be integral to the frame or pressure plate.
  - 7. Finished units to be provided with OSHA required, formed aluminum splash guards to enclose exterior channel plate and gasket surfaces.
  - 8. Provide two sets of replacement gaskets and provide one set of wrenches for disassembly of plate type heat exchangers.
  - 9. Performance: As scheduled on drawings.
- B. Air Purger: Cast iron or fabricated steel, 861 kPa (125 psig) water working pressure, for in-line installation.
- C. Tangential Air Separator: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. If scheduled on the drawings, provide

a removable stainless steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.

- D. Diaphragm Type Pre-Pressurized Expansion Tank: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, welded steel shell, rust-proof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 116 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).
- E. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).
- F. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.
- G. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

## **2.18 WATER FILTERS AND POT CHEMICAL FEEDERS**

- A. See Section 23 25 00, HVAC WATER TREATMENT, Article, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

## **2.19 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.
- C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.
  - 1. For condenser water suction (compound): Minus 100 kPa (30 inches Hg) to plus 700 kPa (100 psig).

## **2.20 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently

installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

- B. Provide one each of the following test items to the Resident Engineer:
1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug.
  2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, 100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
  3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

## **2.21 THERMOMETERS**

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges:
1. Chilled Water: 0-38 degrees C (32-100 degrees F).
  2. Hot Water: -1 - 116 degrees C (30-240 degrees F).

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Water treatment pot feeders and condenser water treatment systems.
  - 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- K. Where copper piping is connected to steel piping, provide dielectric connections.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. Mechanical Joint (may not be used in trenches or inaccessible locations): Pipe grooving shall be in accordance with joint manufacturer's

specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.

- D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- E. Solvent Welded Joints: As recommended by the manufacturer.

### **3.3 Cased Piping Installation (For Underground Chilled Water)**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Remove standing water in the bottom of trench.
- C. Do not backfill piping trench until field quality-control testing has been completed and results approved.
- D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.
- E. In conduits, install drain valves at low points and manual air vents at high points.
- F. Install components with pressure rating equal to or greater than system operating pressure.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- J. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.
- K. Install cathodic protection per Section 26 42 00, CATHODIC PROTECTION.

### **3.4 Expansion Joints (Bellows and Slip Type)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.



- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

### **3.5 SEISMIC BRACING ABOVEGROUND PIPING**

- A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Refer also to Paragraph 1.6 above.

### **3.6 FLEXIBLE EXPANSION LOOP (THERMAL AND SEISMIC APPLICATIONS)**

- A. Install per manufacturer's recommendations.
- B. Access: Expansion loops must be located in readily accessible space. Locate loops to permit access without removing piping or other devices. Allow clear space to permit replacement of loops.

### **3.7 LEAK TESTING PIPING (Refer also to Paragraph 3.8.A.1)**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.
- D. Refer to Section 33 63 00, Paragraph 3.18 Tests for testing of underground, direct buried piping.

### **3.8 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
  - 1. New piping is an extension of and connected to existing piping distribution and equipment. Existing piping and equipment shall be segregated via existing valving from all cleaning, flushing, testing and treatment. Provide for all equipment, chemicals, pumping and disposal required.

2. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.
3. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
4. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### **3.9 WATER TREATMENT**

- A. Refer also to article, Flushing and Cleaning Piping Systems, Subparagraph A.
- B. Install water treatment equipment and provide water treatment system piping.
- C. Close and fill system as soon as possible after final flushing to minimize corrosion.
- D. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- E. Utilize this activity, by arrangement with the Resident Engineer, for instructing VA operating personnel.

**3.10 OPERATING AND PERFORMANCE TEST AND INSTRUCTION**

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Adjust red set hand on pressure gages to normal working pressure.

**3.11 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

**3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 21 23**

**HYDRONIC PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hydronic pumps for Heating, Ventilating and Air Conditioning.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- I. Section 23 21 13, HYDRONIC PIPING.
- J. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- K. Section 26 29 11, MOTOR STARTERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Design Criteria:
1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
  2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.

3. Head-capacity curves shall slope up to maximum head at shut-off. Curves shall be relatively flat for closed systems. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

C. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  1. Pumps and accessories.
  2. Motors and drives.
  3. Variable speed motor controllers.
- C. Manufacturer's installation, maintenance and operating instructions, in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.
- E. Maintenance and Operating Manuals in accordance with Section 01 00 00, General Requirements.

- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only:
- B. American Iron and Steel Institute (AISI):
  - 1. AISI 1045 Cold Drawn Carbon Steel Bar, Type 1045
- C. American National Standards Institute (ANSI):
  - 1. ANSI B15.1-00 (R2008) Safety Standard for Mechanical Power Transmission Apparatus
  - 2. ANSI B16.1-05 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
- D. American Society for Testing and Materials (ASTM):
  - 1. A48-03 (2008) Standard Specification for Gray Iron Castings
  - 2. B62-2009 Standard Specification for Composition Bronze or Ounce Metal Castings
  - 3. B584-2011 Standard Specification for Copper Alloy Sand Castings for General Applications

#### **1.6 DEFINITIONS**

- A. Capacity: Liters per second (L/s) (Gallons per minute (GPM) of the fluid pumped.
- B. Head: Total dynamic head in kPa (feet) of the fluid pumped.
- C. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

#### **1.7 SPARE MATERIALS**

- A. Furnish one spare seal and casing gasket for each pump to the Resident Engineer or Project Manager.

## **PART 2 - PRODUCTS**

### **2.1 CENTRIFUGAL PUMPS, BRONZE FITTED**

#### **A. General:**

1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1-1/2 times the designed pressure.
3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
4. General Construction Requirements
  - a. Balance: Rotating parts, statically and dynamically.
  - b. Construction: To permit servicing without breaking piping or motor connections.
  - c. Pump Motors: Provide high efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. Motors shall be Open Drip Proof and operate at 1750 rpm unless noted otherwise.
  - d. Heating pumps shall be suitable for handling water to 225°F.
  - e. Provide coupling guards that meet ANSI B15.1, Section 8 and OSHA requirements.
  - f. Pump Connections: Flanged.
  - g. Pump shall be factory tested.
  - h. Performance: As scheduled on the Contract Drawings.
5. Variable Speed Pumps:
  - a. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor.
  - b. Variable Speed Motor Controllers: Refer to Section 26 29 11, MOTOR STARTERS and to Section 23 05 11, COMMON WORK RESULTS FOR HVAC paragraph, Variable Speed Motor Controllers. Furnish controllers with pumps and motors.
  - c. Pump operation and speed control shall be as shown on the drawings.

#### **B. Base Mounted End Suction or Double Suction Type:**

1. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.
2. Casing Wear Rings: Bronze, replaceable.
3. Suction and Discharge: Plain face flange, 850 kPa (125 psig), ANSI B16.1.
4. Casing Vent: Manual brass cock at high point.
5. Casing Drain and Gage Taps: 15 mm (1/2-inch) plugged connections minimum size.



- C. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft, cast bronze, ASTM B584, statically and dynamically balanced. For pumps not VFD controlled, trim impeller to match specified performance.
  - 1. Shaft: Steel, AISI Type 1045 or stainless steel.
  - 2. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped, complete with Buna-N or EPT bellows and gasket.
  - 3. Shaft Sleeve: Bronze or stainless steel.
  - 4. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
  - 5. Base Mounted Pumps:
    - a. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
    - b. Impeller Wear Rings: Bronze.
    - c. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate.
    - d. Bearings: Regreaseable ball or roller type. Provide lip seal and slinger outboard of each bearing.
    - e. Base: Cast iron or fabricated steel for common mounting to a concrete base.
  - 6. Provide line sized shut-off valve and suction strainer, maintain manufacturer recommended straight pipe length on pump suction (with blow down valve). Contractor option: Provide suction diffuser as follows:
    - a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 5 mm (3/16-inch) diameter openings for pump protection. Provide taps for strainer blowdown and gage connections.
    - b. Strainer free area: Not less than five times the suction piping.
    - c. Provide disposable start-up strainer.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.
- B. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.
- C. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

#### **3.2 START-UP**

- A. Verify that the piping system has been flushed, cleaned and filled.

- B. Lubricate pumps before start-up.
- C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.
- D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.
- E. Field modifications to the bearings and or impeller (including trimming) are not permitted. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.
- F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.
- G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 22 13**

**STEAM AND CONDENSATE HEATING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Steam, condensate and vent piping inside buildings and exterior in vaults, tunnels, and trenches, not covered under Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION. Co-generation plant, Boiler plant and outside steam distribution piping is covered in specification Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION and Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.

**1.2 RELATED WORK**

- A. Excavation and backfill: Section 31 20 00, EARTH MOVING.
- B. Underground steam and condensate distribution: Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklist, and training.
- F. Seismic restraints for piping: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- G. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Pumps: Section 23 22 23, STEAM CONDENSATE PUMPS.
- I. Piping insulation: Section 23 07 11, HVAC, PLUMBING, AND COGENERATION PLANT INSULATION.
- J. Boiler piping: Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.
- K. Water treatment for open and closed systems: Section 23 25 00, HVAC WATER TREATMENT.
- L. Heating Coils and Humidifiers: SECTION 23 31 00, HVAC DUCTS AND CASING.
- M. Temperature and pressure sensors and valve operators: Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.

### **1.3 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Pipe and equipment supports. Submit calculations for variable spring and constant support hangers.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Valves of all types.
  - 6. Strainers.
  - 7. Pipe alignment guides.
  - 8. Expansion compensators.
  - 9. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
  - 10. All specified steam system components.
  - 11. Gages.
  - 12. Thermometers and test wells.
  - 13. Electric heat tracing systems.
- C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
  - 1. Heat Exchangers (Steam-to-Hot Water).
  - 2. Air Separators.
  - 3. Expansion Tanks.
  - 4. Flash tanks.
- D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- E. Seismic calculations, details, anchors and restraining devices required to meet requirements including supporting steel.
- F. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.
  - 1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.

2. One set of reproducible drawings.

G. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI):
1. B1.20.1-83(R2006) Pipe Threads, General Purpose (Inch)
  2. B16.4-2006 Gray Iron Threaded Fittings
- C. American Society of Mechanical Engineers (ASME):
1. B16.3-2006 Malleable Iron Threaded Fittings
  2. B16.5-2009 Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 - Metric/Inch Standard
  3. B16.9-2007 Factory-Made Wrought Buttwelding Fittings
  4. B16.11-2005 Forged Fittings, Socket-Welding and Threaded
  5. B16.18-12 Cast Copper Alloy Solder Joint Pressure Fittings
  6. B16.22-2001 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  7. B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500
  8. B16.39-98 Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
  9. B16.42-11 Ductile Iron Pipe Flanges and Flanged Fittings
  10. B31.1-2007 Power Piping
  11. Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels, Division 1
- D. American Society for Testing and Materials (ASTM):
1. A53-2007 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  2. A106-2008 Seamless Carbon Steel Pipe for High-Temperature Service

3. A116-2005 Metallic-Coated, Steel Woven Wire Fence Fabric
4. A216-2008 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
5. A307-2004e01 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
6. A516-2006 Pressure Vessel Plates, Carbon Steel, for Moderate-and-Lower Temperature Service
7. B32-2008 Solder Metal
8. B62-2009 Composition Bronze or Ounce Metal Castings
9. B88-2003 Seamless Copper Water Tube

E. American Welding Society (AWS):

1. A5.8-2004 Filler Metals for Brazing and Braze Welding
2. B2.1-00 Welding Procedure and Performance Qualifications

F. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:

1. SP-70-98 Cast Iron Gate Valves, Flanged and Threaded Ends
2. SP-71-97 Gray Iron Swing Check Valves, Flanged and Threaded Ends
3. SP-80-97 Bronze Gate, Globe, Angle and Check Valves
4. SP-85-94 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends

G. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving Capacities of Safety Valves and Relief Valves

H. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

## 1.6 SEISMIC REQUIREMENTS:

- A. Seismic design is the responsibility of the Contractor and shall comply with the requirements of Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Fittings, anchors, guides and other piping supports called for on the drawings or specifications shall be assumed to be for general support or related to thermal expansion and shall not be assumed to be usable for seismic duty. The Contractor shall provide for all design, detailing and construction material and labor required for a complete seismic resistance system for the steam and condensate piping within the trenches, tunnels and vaults as well as all steam and condensate piping within the buildings, above or below grade, independent of restraints, anchors and supports shown. With the Resident Engineer's approval, the Contractor may request that components shown for general support and or thermal anchoring and guiding, be allowed as a component of the complete seismic restraining system pursuant to supporting calculations and approval by the project structural engineer of record.

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **2.2 PIPE AND TUBING**

- A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; ASTM A106 Grade B, Seamless; Schedule 40.
- B. Steam Condensate and Pumped Condensate Piping:
  - 1. Concealed above ceiling, in wall or chase: Copper water tube ASTM B88, Type K, hard drawn.
  - 2. All other locations: Copper water tube ASTM B88, Type K, hard drawn; or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80.
- C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40, galvanized.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded.
  - 1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
  - 2. Forged steel, socket welding or threaded: ASME B16.11.
  - 3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron, except for steam and steam condensate piping. Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
  - 4. Unions: ASME B16.39.
  - 5. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.
- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
  - 1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  - 2. Welding flanges and bolting: ASME B16.5:
    - a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for

saturated and superheated steam service 750 degrees F and 1500 psi.

- b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

## **2.4 FITTINGS FOR COPPER TUBING**

- A. Solder Joint:

- 1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

- B. Bronze Flanges and Flanged Fittings: ASME B16.24.

- C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

## **2.5 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.

- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

- C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

- D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

- E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass gate valves may be used in lieu of dielectric unions.

## **2.6 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.

- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## **2.7 VALVES**

- A. Asbestos packing is not acceptable.

- B. All valves of the same type shall be products of a single manufacturer.

- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2100 mm (7 feet) or more above the floor or operating platform.



D. Shut-Off Valves

1. Gate Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.
- b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.
  - 1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.
  - 2) All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
  - 1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
  - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves

- a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
- b. 65 mm (2 1/2 inches) and larger:
  - 1) Angle valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
  - 2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle valves.

F. Swing Check Valves

- 1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.
- 2. 65 mm (2-1/2 inches) and Larger:
  - a. Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

- b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

- G. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

## **2.8 STRAINERS**

- A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.
- B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).
  - 2. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.
- C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Cast iron or bronze.
  - 2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.
- D. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
  - 1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
  - 2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

## **2.9 PIPE ALIGNMENT**

- A. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

## **2.10 EXPANSION JOINTS**

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Minimum Service Requirements:
  - 1. Pressure Containment:
    - a. Steam Service 35-200 kPa (5-30 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
    - b. Steam Service 214-850 kPa (31-125 psig): Rated 1025 kPa (150 psig) at 186 degrees C (366 degrees F).

- c. Steam Service 869-1025 kPa (126-150 psig): Rated 1375 kPa (200 psig) at 194 degrees C (382 degrees F).
  - d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (310 degrees F).
- 2. Number of Full Reverse Cycles without failure: Minimum 1000.
- 3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- D. Bellows - Internally Pressurized Type:
  - 1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  - 2. Internal stainless steel sleeve entire length of bellows.
  - 3. External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
  - 4. Welded ends.
  - 5. Design shall conform to standards of EJMA and ASME B31.1.
  - 6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  - 7. Integral external cover.
- E. Bellows - Externally Pressurized Type:
  - 1. Multiple corrugations of Type 304 stainless steel.
  - 2. Internal and external guide integral with joint.
  - 3. Design for external pressurization of bellows to eliminate squirm.
  - 4. Welded ends.
  - 5. Conform to the standards of EJMA and ASME B31.1.
  - 6. Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
  - 7. Integral external cover and internal sleeve.
- F. Where joints are required to accommodate both axial and lateral movement, provide appropriate system, such as self-equalizing, ring-controlled expansion joint for or metal corrugated style with control rods made of hydroformed T304 stainless steel, 150 psi pressure class for chilled water. As an alternate, universal, gimbal type joints shall be used.
- G. Expansion Joint Identification: Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

## **2.11 STEAM SYSTEM COMPONENTS**

### **A. Steam Pressure Reducing Valves in PRV Stations:**

1. Type: Single-seated, diaphragm operated, spring-loaded, external or internal steam pilot-controlled, normally closed, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
2. Service: Provide controlled reduced pressure to steam piping systems.
3. Pressure control shall be smooth and continuous with maximum drop of 10 percent. Maximum flow capability of each valve shall not exceed capacity of downstream safety valve(s).
4. Main valve and pilot valve shall have replaceable valve plug and seat of stainless steel, monel, or similar durable material.
  - a. Pressure rating for high pressure steam: Not less than 1034 kPa (150 psig) saturated steam.
  - b. Connections: Flanged for valves 65 mm (2-1/2 inches) and larger; flanged or threaded ends for smaller valves.
5. Select pressure reducing valves to develop less than 85 dbA at 1500 mm (5 feet) elevation above adjacent floor, and 1500 mm (5 feet) distance in any direction. Inlet and outlet piping for steam pressure reducing valves shall be Schedule 80 minimum for required distance to achieve required levels or sound attenuators shall be applied.
6. Pneumatically controlled valve: May be furnished in lieu of steam-operation. All specification requirements for steam operated valves apply. Valves shall close on failure of air supply.

### **B. Safety Valves and Accessories: Comply with ASME Boiler and Pressure Vessel Code, Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown.**

### **C. Steam PRV for Individual Equipment: Cast iron or bronze body, screwed or flanged ends, rated 861 kPa (125 psig) working pressure. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.**

### **D. Flash Tanks: Horizontal or vertical vortex type, constructed of copper bearing steel, ASTM A516 or ASTM A285, for a steam working pressure of 861 kPa (125 psig) to comply with ASME Code for Unfired Pressure Vessels and stamped with "U" symbol. Perforated pipe inside tank shall be ASTM A53 Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80. Corrosion allowance of 1.6 mm (1/16 inch) may be provided in lieu of the copper bearing requirement. Provide data Form No. U-1.**

### **E. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (200 feet) intervals on the horizontal main lines.**

1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:

- a. For equipment with modulating control valve: 1.7 kPa (1/4 psig), based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
    - b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
  - 2. Trap bodies: Bronze, cast iron, or semi-steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping. For systems without relief valve traps shall be rated for the pressure upstream of the PRV supplying the system.
  - 3. Balanced pressure thermostatic elements: Phosphor bronze, stainless steel or monel metal.
  - 4. Valves and seats: Suitable hardened corrosion resistant alloy.
  - 5. Mechanism: Brass, stainless steel or corrosion resistant alloy.
  - 6. Floats: Stainless steel.
  - 7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.
  - 8. Steam traps inside vaults below grade shall be electronically monitored. Refer to Section 33 63 00, STEAM and CHILLED WATER SITE DISTRIBUTION.
- F. Thermostatic Air Vent (Steam): Brass or iron body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.
- G. Steam Flow Meter/Recorder: Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.
- H. Steam Exhaust Head: Cast iron, fitted with baffle plates, to trap and drain condensed water.

## **2.12 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.

- C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

Low pressure steam and steam condensate to 103 kPa (15 psig)	0 to 207 kPa (30 psig).
Medium pressure steam and steam condensate nominal 413 kPa (60 psig)	0 to 689 kPa (100 psig).
High pressure steam and steam condensate nominal 620 kPa to 861 kPa (90 to 125 psig)	0 to 1378 kPa (200 psig).

PRESSURE/TEMPERATURE TEST PROVISIONS

- D. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- E. Provide one each of the following test items to the Resident Engineer:
1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug.
  2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, 762 mm (30 inches) Hg to 689 kPa (100 psig) range.
  3. 0 - 104 degrees C (32-220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- I. Where copper piping is connected to steel piping, provide dielectric connections.
- J. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25 percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

### **3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

### **3.4 STEAM TRAP PIPING**

- A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (25 pounds) independently of connecting piping.

### **3.5 SEISMIC BRACING**

- A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Refer also to Paragraph 1.6 above.

### **3.6 LEAK TESTING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

### **3.7 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
  - 1. New piping is an extension of and connected to existing piping distribution and equipment. Existing piping and equipment shall be segregated via existing valving from all cleaning, flushing, testing



and treatment. Provide for all equipment, chemicals, pumping and disposal required.

- B. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

### **3.8 OPERATING AND PERFORMANCE TEST AND INSTRUCTION**

- A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Adjust red set hand on pressure gages to normal working pressure.
- C. Demonstrate leak-tightness of all steam and condensate piping systems by performing hydrostatic and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments, test pressures and durations must be approved by the RE/COTR.

### **3.9 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -



**SECTION 23 22 23**

**STEAM CONDENSATE PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Steam condensate pumps for Heating, Ventilating and Air Conditioning.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- I. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
- J. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Design Criteria:
1. Pumps design and manufacture shall conform to Hydraulic Institute Standards.
  2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
  3. Select pumps so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).

4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve including one pump operation in a parallel or series pumping installation.
5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
9. Furnish one spare seal and casing gasket for each pump to the Resident Engineer .

C. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  1. Pumps and accessories.
  2. Motors and drives.
- C. Manufacturer's installation, maintenance and operating instructions, in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC
- D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump.
- E. Maintenance and Operating Manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

- G. Maintenance and Operating Manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only:
- B. American Iron and Steel Institute (AISI):
1. AISI 416 Type 416 Stainless Steel

#### **1.6 DEFINITIONS**

- A. Capacity: Liters per second (L/s) (Gallons per minute (GPM)) of the fluid pumped.
- B. Head: Total dynamic head in kPa (feet) of the fluid pumped.

### **PART 2 - PRODUCTS**

#### **2.1 CONDENSATE PUMP, PAD-MOUNTED**

- A. General: Factory assembled unit consisting of vented receiver tank, motor-driven pumps, interconnecting piping and wiring, motor controls (including starters, if necessary) and accessories, designed to receive, store, and pump steam condensate.
- B. Receiver Tank: Cast iron with threaded openings for connection of piping and accessories and facilities for mounting float switches. Receivers for simplex pumps shall include all facilities for future mounting of additional pump and controls.
- C. Furnish seals for condensate pump with a minimum temperature rating of 121 degrees C (250 degrees F).
- D. Centrifugal Pumps: Bronze fitted with mechanical shaft seals.
1. Designed to allow removal of rotating elements without disturbing connecting piping or pump casing mounting.
  2. Shafts: Stainless steel, AISI Type 416 or alloy steel with bronze shaft sleeves.
  3. Bearings: Regreaseable ball or roller type.
  4. Casing wearing rings: Bronze.
- E. Motors: Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- F. Pump Operation:
1. Float Switches: NEMA 1, mounted on receiver tank, to start and stop pumps in response to changes in the water level in the receiver and

adjustable to permit the controlled water levels to be changed. Floats and connecting rods shall be copper, bronze or stainless steel.

2. Alternator: Provide for duplex units to automatically start the second pump when the first pump fails in keeping the receiver water level from rising and to alternate the order of starting the pumps. For units 0.25 kW (1/3 horsepower) and smaller, the alternator may be the mechanical type for use in lieu of float switches.
- G. Control Cabinet for 3 Phase (0.37 kW (1/2 hp) and larger) Units: NEMA 1, UL approved, factory wired, enclosing all controls, with indicating lights, manual switches and resets mounted on the outside of the panel. Attach cabinet to the pump set with rigid steel framework, unless remote mounting is noted on the pump schedule.
1. Motor starters: Magnetic contact types with circuit breakers or combination fusible disconnect switches. Provide low voltage control circuits (120 volt maximum) and "hand-off-automatic" (H-O-A) switches for each pump.
  2. Indicating lights for each pump: Green to show that power is on, red to show that the pump is running.
- H. Electric Wiring: Suitable for 93 degrees C (200 degrees F) service; enclosed in liquid-tight flexible metal conduit where located outside of control cabinet.
- I. Receiver Accessories:
1. Thermometer: 34-216 degrees C (100 - 420 degrees F), mounted below minimum water level.
  2. Water level gage glass: Brass with gage cocks which automatically stop the flow of water when the glass is broken. Provide drain on the lower gage cock and protection rods for the glass.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.
- B. Permanently support in-line pumps by the connecting piping only, not from the casing or the motor eye bolt.
- C. Sequence of installation for base-mounted pumps:
1. Level and shim the unit base and grout to the concrete pad.
  2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts.
  3. Connect properly aligned and independently supported piping.
  4. Recheck alignment.

- D. Pad-mounted Condensate Pump : Level, shim, bolt, and grout the unit base onto the concrete pad.
- E. Coordinate location of thermometer and pressure gauges as per Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

### **3.2 START-UP**

- A. Verify that the piping system has been flushed, cleaned and filled.
- B. Lubricate pumps before start-up.
- C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.
- D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.
- E. Field modifications to the bearings and or impeller (including trimming) are not permitted. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 23 00**

**REFRIGERANT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field refrigerant piping for direct expansion HVAC systems.
- B. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.
- C. Definitions:
  - 1. Refrigerating system: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
    - a. Low side means the parts of a refrigerating system subjected to evaporator pressure.
    - b. High side means the parts of a refrigerating system subjected to condenser pressure.
  - 2. Brazed joint: A gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.
- D. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- F. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION: Requirements for piping insulation.

G. Section 23 81 26, SPLIT SYSTEM AIR CONDITIONERS

### **1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC
- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

### **1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
    - a. Tubing and fittings
    - b. Valves
    - c. Strainers
    - d. Moisture-liquid indicators
    - e. Filter-driers
    - f. Flexible metal hose
    - g. Liquid-suction interchanges
    - h. Oil separators (when specified)
    - i. Gages
    - j. Pipe and equipment supports
    - k. Refrigerant and oil
    - l. Pipe/conduit roof penetration cover
    - m. Soldering and brazing materials
  - 2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.
- D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

- E. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI):
  - 1. 730-2005 Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
  - 2. 750-2007 Thermostatic Refrigerant Expansion Valves
  - 3. 760-2007 Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
- C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
  - 1. ANSI/ASHRAE 15-2007 Safety Standard for Refrigeration Systems (ANSI)
  - 2. ANSI/ASHRAE 17-2008 Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)
  - 3. 63.1-95 (RA 01) Method of Testing Liquid Line Refrigerant Driers (ANSI)
- D. American National Standards Institute (ANSI):
  - 1. ASME (ANSI) A13.1-1996 (R2002) Scheme for Identification of Piping Systems
- E. American Society of Mechanical Engineers (ASME):
  - 1. ANSI/ASME B16.22-2001 (R2005) Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
  - 2. ANSI/ASME B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)
  - 3. ANSI/ASME B31.5-2006 Refrigeration Piping and Heat Transfer Components (ANSI)
  - 4. ANSI/ASME B40.100-2005 Pressure Gauges and Gauge Attachments
  - 5. ANSI/ASME B40.200-2008 Thermometers, Direct Reading and Remote Reading

F. American Society for Testing and Materials (ASTM)

1. A126-04 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings B32-08 Standard Specification for Solder Metal
2. B32-08 Solder Metal
3. B88-03 Standard Specification for Seamless Copper Water Tube
4. B88M-05 Standard Specification for Seamless Copper Water Tube (Metric)
5. B280-03 Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

G. American Welding Society, Inc. (AWS): Brazing Handbook

1. A5.8/A5.8M-04 Standard Specification for Filler Metals for Brazing and Braze Welding

H. Underwriters Laboratories (U.L.):

1. U.L.207-2009 Standard for Refrigerant-Containing Components and Accessories, Nonelectrical
2. U.L.429-99 (Rev.2006) Standard for Electrically Operated Valves

## **PART 2 - PRODUCTS**

### **2.1 PIPING AND FITTINGS**

- A. Refrigerant Piping: For piping up to 100 mm (4 inch) use copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer. For piping over 100 mm (4 inch) use A53 Black SML steel.
- B. Water and Drain Piping: Copper water tube, ASTM B88M, Type B or C (ASTM B88, Type M or L). Optional drain piping material: Schedule 80 flame retardant Polypropylene plastic).
- C. Fittings, Valves and Accessories:
1. Copper fittings: Wrought copper fittings, ASME B16.22.
    - a. Braze Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
    - b. Solder Joints, water and drain: 95-5 tin-antimony, ASTM B32 (95TA).
  2. Flanges and flanged fittings: ASME B16.24.
  3. Refrigeration Valves:
    - a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
    - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron

- bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
- c. Solenoid Valves: Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor-proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and holding coil.
  - d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
  - e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
- 4. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines DN 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
  - 5. Refrigerant Moisture/Liquid Indicators: Double-ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
  - 6. Refrigerant Filter-Dryers: UL listed, angle or in-line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.
  - 7. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.

## **2.2 GAGES**

- A. Temperature Gages: Comply with ASME B40.200. Industrial-duty type and in required temperature range for service in which installed. Gages shall have Celsius scale in 1-degree (Fahrenheit scale in 2-degree) graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in thermal wells located within 1525 mm (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal

wells located 1525 to 2135 mm (5 to 7 feet) above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 2135 mm (7 feet) above the finished floor.

- B. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 90 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

1. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
2. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

## **2.3 THERMOMETERS AND WELLS**

- A. Refer to specification Section 23 21 13 HYDRONIC PIPING.

## **2.4 PIPE SUPPORTS**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## **2.5 REFRIGERANTS AND OIL**

- A. Provide EPA approved refrigerant and oil for proper system operation.

## **2.6 PIPE INSULATION FOR DX HVAC SYSTEMS**

- A. Refer to specification Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
  2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
  3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
  4. Use copper tubing in protective conduit when installed below ground.

5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.

B. Joint Construction:

1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
  - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
  - b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
  - c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
  - d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.

- C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.

- D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs) of refrigerant.

- E. Seismic Bracing: Refer to specification Section 13 05 41, SEISMIC RESTRAINTS REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, for bracing of piping in seismic areas.

### **3.2 PIPE AND TUBING INSULATION**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Apply two coats of weather-resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.

### **3.3 SIGNS AND IDENTIFICATION**

- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.

### **3.4 FIELD QUALITY CONTROL**

- A. Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- B. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
  - 1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
  - 2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- C. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.

### **3.5 SYSTEM TEST AND CHARGING**

- A. System Test and Charging: As recommended by the equipment manufacturer or as follows:
  - 1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
  - 2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.
  - 3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) 665 mPa (2245.6 inches of mercury at 60 degrees F) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.



- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.7 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 24 01**

**THERMAL ENERGY STORAGE TANK SYSTEM PERFORMANCE TESTING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This specification outlines the steps required for performance testing of the chilled water Thermal Energy Storage (TES) tank system.

**1.2 RELATED WORK**

- A. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- B. Section 23 85 00, THERMAL ENERGY STORAGE TANK SYSTEM: Thermal storage tank design.

**1.3 SCOPE**

- A. This specification includes the requirements for conducting the performance test as well as the duties of the owner/operator of the tank, the Contractor, and the tank manufacturer.
- B. The full TES tank system performance test is comprised of three individual tests: Recharge Test, Hold Test, and Discharge Test. Not all parts of the testing described in this specification may be required to prove performance; refer to contract documentation for project specific test scope.

**1.4 DEFINITIONS**

- | A. Terminology:             | DEFINITION  |
|-----------------------------|---|
| Term                        |   |
| CHWR - Chilled Water Return | Chilled water that is returned from the system after cooling has been provided. Describes the temperature or flow rate of water entering (during discharge) or leaving (during recharge) the top of the tank. |
| CHWS- Chilled Water Supply  | Chilled water that is supplied to the system to provide cooling. Describes the temperature or flow rate of water entering (during recharge) or leaving (during discharge) the bottom of the tank.             |
| Recharge                    | Operational mode that replenishes the TES tank thermal capacity by removing CHWR from the top of the  |

	tank, cooling it to the CHWS temperature, and directing the CHWS back to the bottom of the tank.
Discharge	Operational mode that expends the TES tank thermal capacity by removing CHWS from the bottom of the tank, supplying it to the plant or building load, and directing the CHWR back to the top of the tank.
Refrigeration Rate	Instantaneous refrigeration delivered by the TES tank (tons), as determined by the mass flow rate and the temperature difference between the CHWS and CHWR.
Thermal Storage Capacity	Total thermal capacity the tank is capable of storing and delivering (ton-hrs). Total thermal capacity is assessed by the Recharge and Discharge Tests.
Heat Leak	Amount of external energy that enters the tank water volume, usually measured over a 24 hr period. Heat leak is assessed by a Hold Test.
Thermocline	Temperature & density transition region between bulk cold water below and bulk warm water above IPC-06.

## 1.5 RESPONSIBILITIES

- A. Contractor: The Contractor shall be responsible for ensuring that the tank is properly connected to the system piping, and that all system components and operational software necessary for the performance test are functional and ready. Testing is the responsibility of the Contractor in conjunction with the TES tank manufacturer and shall be coordinated with the Owner.
  - 1. The Contractor shall coordinate with the Owner regarding all aspects of the performance test that may involve components of the chilled water system in use and in operation by the Owner so that the Owner can be prepared to assist the Contractor in such things as making sure chilled water plant is operated during testing as required to allow the tank to be properly tested.
  - 2. The Contractor shall furnish all meters, sensors, gages and instruments as required to gather the appropriate information required during testing.
- B. Tank Manufacturer:
  - 1. The Tank Manufacturer shall be responsible for providing direction to the Contractor for the proper execution of the performance test. This may include providing data logging forms, telephone support to testing personnel during pre-test conditioning, and witnessing the test.

2. The Tank Manufacturer shall be responsible for assessing the performance test data, determining the outcome of the test, and providing the Owner with final results in the form of a Performance Test Report.

## **PART 2 - PRODUCTS (NOT USED)**

## **PART 3 - EXECUTION**

### **3.1 TEST PROCEDURE**

- A. Test Parameters: Testing shall be conducted using the following design parameters:
  1. Design chilled water supply (CHWS) temperature: 42 deg F.
  2. Design chilled water return (CHWR) temperature: 58 deg F.
  3. Design thermal storage capacity: 5,000 Ton-hour.
  4. Design recharge flow rate: 1,500 gpm.
  5. Design discharge flow rate: 1,500 gpm.
  6. Design heat leak allowance: 2 percent total capacity / 24 hrs
  7. Design pressure drop: 3 psig.
- B. Design parameters, particularly flow rate and CHWR temperature, may not be achievable during the test period. Any cause for deviation shall be noted during the test and accounted for in the data assessment and analysis.
- C. Test Preparation:
  1. Testing shall be conducted at or near initial system start-up, however not longer than 30 days after substantial completion of tank system.
  2. Contractor shall notify Tank Manufacturer at least fourteen (14) days in advance of start-up and performance testing.
  3. Tank Manufacturer shall visually inspect the TEST tank system exterior to ensure that the tank has been properly maintained and is in good repair.
  4. The following instrumentation and systems shall be provided, installed and made operational by the Contractor unless otherwise specified:
    - a. Water flow meter to measure water flow rates either into or out of TES tank system.
    - b. Temperature sensors (RTD's) at both the warm water nozzle and the cold water nozzle to continuously measure temperatures of the Chilled Water Return (CHWR) and Chilled Water Supply (CHWS) flow into and out of the TES tank system.
    - c. Internal tank system temperature sensors (RTD's) to monitor thermal charge.
    - d. Level instrumentation to verify tank water level.

- e. Ambient air temperature sensor (RTD) or thermometer (dry bulb).
  - f. Inlet and outlet pressure sensors or a  $\Delta P$  sensor located near the tank nozzles, to measure TES tank system pressure drop (optional).
  - g. Monitoring or read-out instruments for collecting data from items 1 through 6.
  - h. Chiller plant capacity to supply cold water during the recharge cycle.
  - i. Thermal load for discharge cycle.
5. To ensure that the entire system is operational, the Contractor shall forward data to the Tank Manufacturer indicating that the instrumentation is gathering data in both the recharging and discharging modes at least seven (7) prior to notice of start-up and testing. This shall include calibration data for all flow and temperature devices.

D. Initialization:

- 1. Contractor shall fill the TES tank system to maximum operating height. In order to eliminate transient effects due to the first-time cool-down of the tank, its foundation, and the soil, the TES tank system shall be chilled to within the operating temperature range (CHWS temperature to CHWR temperature) and the bottom eight feet maintained at the CHWS temperature for a minimum of three days (72 hours). This should be completed prior to the performance test.
- 2. Immediately prior to execution of the performance test, the TES tank system shall be brought to a fully discharged condition. This shall be accomplished by withdrawing cold water from the bottom of the tank and returning warm water to the top of the tank at no less than the CHWR temperature until the average temperature of water stored in the tank is no less than the CHWR temperature. This shall be completed no more than eight (8) hours prior to the start of testing.

E. Recharge Test

- 1. Warm water shall be withdrawn from top of storage up to the design maximum recharge flow rate. The warm water will be cooled and returned at the same flow rate to the bottom of the tank at the CHWS temperature or lower (maximum tolerance:  $-1^{\circ}\text{F}$ , not to fall below  $39.0^{\circ}\text{F}$ ).
- 2. Flow and temperature values at all available locations shall be recorded every minute throughout the entire recharge testing period. The test data shall be averaged over 15 minute intervals. Refrigeration delivered during each 15 minute interval can be determined by:

$$q_i = V_i p \cdot c_p (T_{w,i} - T_{c,i}) F_I$$

Where:

- $i$  = Specific 15 minute interval
- $q_i$  = Refrigeration rate (tons)
- $v_i$  = Averaged flow rate (gpm)
- $p$  = Mass density (lb/ft<sup>3</sup> - typically 62.43 lb/ft<sup>3</sup> @ 40°F)
- $C_p$  = Specific heat, 1.0 Btu/lb-oF
- $T_{w,i}$  = Averaged warm water temperature (°F)
- $T_{c,i}$  = Averaged cold water temperature (°F)
- $F_I$  = Conversion factor= 0.0006684  
(min-ft<sup>3</sup>-ton/hr-gallon-Btu)
- $T_{db}$  = Ambient air temperature (°F) - for information only

3. Total integrated refrigeration delivered during the recharge period is:

$$Q_{total} = \sum_{i=1}^n \cdot \frac{t_i}{60 \frac{min}{hr}}$$

Where

- $Q_{total}$  = Total refrigeration delivered (tons-hrs)
- $n$  = Total number of intervals
- $q_i$  = Increment refrigeration rate (tons)
- $t_i$  = Time increment duration (minutes)

4. The recharge cycle will continue until one tank volume has been circulated, as demonstrated by water withdrawn from the top of storage being at or near the CHWS temperature and by the data collected from the flow meter. Upon completion of the recharge, total integrated refrigeration delivered to the tank shall be evaluated and used as a basis for the determination of recharge performance. CAUTION: Significant variations in the temperature of the recharge water- especially when the thermocline is at or below the elevation of the lower diffuser- may impair the ability of the tank to stratify the water and invalidate the test.
5. Water depth shall be checked at the start and end of the test.

F. Holding Test:

1. Following completion of the recharge test, or at such time when the tank is completely charged, the tank shall be isolated (with no water flow either into or out of the tank) for a minimum period of 24 hours not to exceed 25 hours. Prior to tank isolation, the water temperature at each internal tank temperature sensor location shall be recorded and an average temperature determined. After 24 hours have passed, a new average temperature shall be determined in the same manner and these values used to determine ambient heat leak. The ambient air temperature shall also be recorded at fifteen (15) minute intervals throughout the test period.
2. Heat leak over the 24 hour test period can be determined by:

$$Q_{leak} = \frac{\pi}{4} D^2 H \rho \cdot c_p (T_{f,avg} - T_{i,avg}) F_2$$

$$\frac{HeatLeak (\%)}{24hrs} = 100 \cdot \frac{Q_{leak} \cdot \frac{24}{t}}{Q_{total}}$$

Where

$Q_{leak}$	=	Tank heat leak (tons-hrs)
$D$	=	Tank diameter (ft)
$H$	=	Tank water level (ft)
$\rho$	=	Mass density (lb/ft <sup>3</sup> ) - typically 62.43 lb/ft <sup>3</sup> @ 40 deg F
$C_p$	=	Specific heat, 1.0 Btu/lb- deg F
$T_{f,avg}$	=	Final average tank temperature (deg F)
$T_{i,avg}$	=	Initial average tank temperature (deg F)
$F_2$	=	Conversion factor = 1/12000 (ton-hr/Btu)
$T$	=	Total hold time (hrs)
$Q_{total}$	=	Ambient air dry bulb temperature (deg F)

3. Using the recorded ambient air temperature and the Tank Manufacturer's insulation sizing calculations, the observed heat leak shall be scaled to reflect the maximum design ambient temperature.

G. Discharge Test:

1. Cold water shall be withdrawn from the bottom of storage at a flow rate less than or equal to the design maximum discharge flow rate. The maximum useful cold supply water (or fluid) temperature from the tank shall be the CHWS temperature +1 deg. F. The cold water will be heated and returned at the same flow rate to the top of the tank at the CHWR temperature or higher. Responsibility for providing adequate thermal load and proper temperature control will be by others.



2. Flow and temperature values at all available locations shall be recorded every minute throughout the entire discharge testing period. The test data shall be averaged over 15 minute intervals. Refrigeration delivered during each 15 minute interval can be determined by:

$$q_i = V_i \cdot p \cdot c_p (T_{w,i} - T_{c,i}) F_i$$

Where

- $i$  = Specific 15 minute interval  
 $q_i$  = Refrigeration rate (tons)  
 $V_i$  = Averaged flow rate (gpm)  
 $p$  = Mass density (lb/ft<sup>3</sup>)-typically 62.43 lb/ft<sup>3</sup>@ 40 deg F  
 $c_p$  = Specific heat, 1.0 Btu/lb - deg F  
 $T_{w,i}$  = Averaged warm water temperature (deg F)  
 $T_{c,i}$  = Averaged cold water temperature (deg F)  
 $F_i$  = Conversion factor=0.0006684 (min-ft<sup>3</sup>-ton/hr-gallon-Btu)  
 $T_{db}$  = Ambient air temperature (deg F)-for information only

3. Total integrated refrigeration delivered during the discharge period is:

$$Q_{total} = \sum_{i=1}^n \cdot \frac{t_i}{60 \frac{min}{hr}}$$

Where

- $Q_{total}$  = Total refrigeration delivered (tons-hrs)  
 $n$  = Total number of intervals  
 $q_i$  = Increment refrigeration rate (tons)  
 $f_i$  = Time increment duration (minutes)

4. The discharge cycle shall continue until one tank volume has been circulated, as demonstrated by the water withdrawn from the bottom of storage being at or near the CHWR temperature and by the data collected from the flow meter. Upon completion of the discharge cycle, total integrated refrigeration delivered will be evaluated and used as a basis for the determination of discharge performance.
5. Water depth shall be checked at the start and end of the test.

6. In the event that inadequate thermal load is available at the time of the performance test to provide a meaningful discharge test, the results of recharge and holding alone may be used as a basis for performance demonstration.

H. Pressure Drop Test:

1. The TES tank system Pressure Drop Test shall be conducted concurrently with the Recharge or Discharge Test, whichever requires the higher design flow rate. Maximum system pressure drop will be the maximum recorded value at stable flow, disregarding pressure spikes caused by equipment external to the TES tank system (e.g. pumps, valves, etc.)
2. The maximum system pressure drop value shall be adjusted to account for any significant pipe length between the tank nozzles and the pressure sensors.
3. The Pressure Drop Test is intended to measure frictional pressure drop only. Gravity head shall be subtracted from the inlet and outlet pressure readings as required (e.g. for dissimilar nozzle elevations).

- I. The accuracy of the flow meter may be confirmed by a check of the movement of the thermocline region (that volume of water in which the cold-to-warm water temperature gradient occurs). During recharge or discharge testing, the time lapse between the thermocline passing by any two given temperature sensors and the vertical distance between those two sensors can be used to calculate an estimated flow rate:

$$V = \frac{\pi}{4} D^2 \frac{(h_2 - h_1)}{(t_2 - t_1)} F_3$$

Where

- |       |   |   |
|-------|---|---|
| $v$   | = | Volumetric flow rate (gpm)                            |
| $D$   | = | Tank diameter (ft)                                    |
| $h_i$ | = | Elevation of sensor #1 (ft)                           |
| $h_l$ | = | Elevation of sensor #2 (ft)                           |
| $t_l$ | = | Time the thermocline passes sensor #1 (seconds)       |
| $t_2$ | = | Time the thermocline passes sensor #2 (seconds)       |
| $F_3$ | = | Conversion factor= 448.8 (gallons-seconds/lfe-minute) |

- J. The accuracy of instrumentation has inherent limits. These limitations shall be considered in evaluating the test data or in determining the need for further or modified testing.
- K. Data sheets appropriate for use in the recharge, holding, and discharge tests follow. Data in Microsoft Excel spreadsheet format is preferable.
- L. The results of the performance test shall be provided in a test report prepared by Contractor. This report shall document all findings from the recharge, holding, and discharge tests. Some sections may be omitted in the event of an inability to collect meaningful data.

M. Exhibits:

Exhibit A            Recharge Test Datasheet

Exhibit B            Holding Test Datasheet

Exhibit C            Discharge Test Datasheet

EXHIBIT A: RECHARGE TEST DATASHEET

[illegible]

Calculate  $q$  using:

Total Refrigeration Delivered (Osum) \_\_\_\_\_ ton-hr

$$Q = V_p \cdot C_p (T_w - T_c) F$$

p = 62.43 lb/ft<sup>3</sup> @ 40°F

$$C_p = 1.0 \text{ Btu/lb-}^\circ\text{F}$$

$$F = 0.0006684 \text{ (min- ft}^3\text{-ton/hr-gallon-Btu)}$$

Temperature Sensor No.	Sensor Elevation	Initial Temperature (Ti)	Final Temperature (Tf)
	ft	Deg. F	Deg. F
Average Temp	°F		

[illegible]

Water Level (H) : \_\_\_\_\_ ft.

$$Q_{leak} = \frac{\pi}{4} D^2 H \rho \cdot c_p (T_{f,avg} - T_{i,avg}) \cdot F$$

Total Tank Thermal Capacity ( $O_{total}$ ): \_\_\_\_\_ft

$p = 62.43 \text{ lbf ft}^3 @ 40\text{Deg. F}$   
ton-hrs

Total Heat Leak ( $Q_{\text{leak}}$ ):

$$\overline{c_P} = 1.0 \text{ Btu/lb-Deg. F}$$

$$F = 1/12000 \text{ (ton-hr/Btu)}$$

Total Hold Time (t):    hrs

$$D = \text{Tank diameter (ft)} \quad \text{Percent Heat Leak in 24 hrs} \left( 100 \cdot \frac{Q_{\text{leak}}}{Q_{\text{total}}} \cdot \frac{24}{t} \right) \underline{\hspace{1cm}} \%$$

[illegible]
$$Q = V_p \cdot C_p (T_w - T_c) F$$

p = 62.43 lb/ft<sup>3</sup> @ 40 Deg. F  
c<sub>p</sub> = 1.0 Btu/lb-Deg. F

$$F = 0.0006684 \text{ (min- ft}^3\text{-ton/hr-gallon-Btu)}$$

### **3.2 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -





**SECTION 23 25 00**

**HVAC WATER TREATMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
  - 1. Cleaning compounds.
  - 2. Chemical treatment for closed loop heat transfer systems.
  - 3. Chemical treatment for open loop systems.
  - 4. Sump cleaning filtration and sweeper system.

**1.2 RELATED WORK**

- A. Test requirements and instructions on use of equipment/system: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- C. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- D. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- E. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Piping and valves: Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.
- G. Cooling Towers: Section 23 65 00, COOLING TOWERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than service calls and written status reports. Emergency calls are not included. During this period perform monthly tests of the cooling tower for Legionella pneumophila and submit reports stating

Legionella bacteria count per millimeter. These tests shall be conducted in a certified laboratory and not by a technician in the field. Minimum service during construction/start-up shall be 6 hours.

- C. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, as stated in paragraph 1.3.B, sample taking and testing, and review with VA personnel, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.
- D. Log Forms: Provide one year supply of preprinted water treatment test log forms.
- E. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data including:
  - 1. Cleaning compounds and recommended procedures for their use.
  - 2. Chemical treatment for closed systems, including installation and operating instructions.
  - 3. Chemical treatment for open loop systems, including installation and operating instructions.
- C. Water analysis verification.
- D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.
- E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- F. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## **1.5 APPLICABLE PUBLICATIONS**

- A. The publication listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. National Fire Protection Association (NFPA):
  - 1. 70-2008 National Electric Code (NEC)
- C. American Society for Testing and Materials (ASTM):
  - 1. F441/F441M-02 (2008) Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

## **PART 2 - PRODUCTS**

### **2.1 CLEANING COMPOUNDS**

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. All chemicals to be acceptable for discharge to sanitary sewer.
- C. Refer to Section 23 21 13, HYDRONIC PIPING, Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS, and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

### **2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS**

- A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
- B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.
- C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

- D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

### 2.3 CHEMICAL TREATMENT FOR OPEN LOOP SYSTEM(S)

#### A. General: Provide the following:

- 1. A factory fabricated and tested packaged, self-contained, chemical feed/blow-down monitoring, controlling and alarming system, containing all except specified or indicated remote components, and requiring only terminal sample stream and chemical piping/tubing connections, remote component electrical connection and power supply.
- 2. System shall be suitable for a broad spectrum make-up water supply and chemical treatment program. Components, except those specified or indicated otherwise, shall be housed in one or more joined or divided steel enclosures.

#### B. System Functions:

- 1. Automatically maintain a predetermined, selectable, total dissolved solids concentration through a continuously monitoring conductivity controller, maintain a predetermined, selectable, scale/corrosion inhibitor and dispersant residual, through a continuously make-up monitoring meter/counter/timer and inhibitor/dispersant ratio controller; achieve a predetermined, selectable, peak concentration of one or two microbiocides as needed on an alternating basis, through a programmable timer controller. De-energize controller or stagger feed chemicals that would degrade or could be incompatible if fed simultaneously.
- 2. Automatically maintain a predetermined, selectable, pH level through a continuously monitoring pH controller. For systems with makeup water alkalinity in excess of 125 PPM or hardness above 300 PPM, provide acid feed limit timer and audible/visual alarm actuated on low pH.

#### C. Main control panel and accessories:

- 1. Housed in a NEMA Type 4X enclosure:
  - a. Hinged key lock door with viewing window.
  - b. Hard wire connected to power source.
  - c. Provide minimum of three (3) 115V, 1 Ph, 60 Hz receptacles located on enclosure for electrical connection and control of chemical pumps.
  - d. Prewired for ease of installation.
- 2. Provide an external combination mounted flow switch with transparent sight tube.
  - a. Disable control outputs upon loss of water flow to prevent chemical feeding.
  - b. Provide complete with 3/4 IN connections and combination conductivity and temperature electrode.

3. Keypad or remote control: Access all measurements and set points through chemical resistant key pad or remote.
  - a. Security code to prevent unauthorized access.
4. Utilize microprocessor technology.
5. Menu driver programs.
6. Liquid crystal display (LCD).
7. Provide temperature corrected measurements by reading water temperature and adjusting conductivity values according to known temperature curve.
  - a. Range: 0-100 deg. C (32-212 deg. F) with an adjustable high alarm.
8. Provide real-time clock.
9. Conductivity monitor:
  - a. Provide linear measurements of full range.
  - b. Provide two scales for selection of high and low in field to assure accurate measurements.
  - c. Provide increments of 1 microohm/cm with adjustable hysteresis.
  - d. Provide bleed-off control in following manner:
    - 1) Standard operation-controller actuates a bleed off solenoid valve when dissolved solids level is exceeded by trip point.
    - 2) Provide an adjustable bleed limit timer to prevent excessive bleed off.
    - 3) An alarm contact shall close when timer has timed out.
10. Biocide operation:
  - a. Provide a programmable 28 day biocide timer for accurate addition of algacide.
  - b. Provide a secondary bleed off timer to lower conductivity in system prior to biocide feed.
  - c. Lock out cooling water bleed-off during biocide feed period.
11. Chemical feed control: Provide three timers that are capable of operating in one of following field programmable modes.
  - a. Counter-timer-chemical feed proportioned to make-up water rate.
    - 1) Controller shall send low voltage signal to a contacting head water meter.
    - 2) Low voltage signal will ensure long contact life.
    - 3) Water meter shall read in gallons.
12. Alarms:
  - a. Provide alarm LEDs with silence button for high and low conductivity, 10-60 minute bleed-off, chemical feed limit timers, and chemical drum level. Provide remote output relay to indicate alarm condition to Building Control System specified under Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.
13. Controller operating data history:
  - a. Retain in memory all operating data for following parameters:
    - 1) Standard memory shall allow acquisition and storage of all analog inputs for a one-week period.

- 2) A three (3) hour minimum, maximum average of all conditions shall be stored for a one-week period.
  - 3) A minute-by-minute account of operating conditions shall be available for latest three-hour period.
14. Electrode: Combination temperature and conductivity type.
  - a. Quick disconnect.
  - b. Supplied in flow switch assembly.
15. Ph monitor:
  - a. Sensor for monitoring purposes only.
  - b. Acid shall not be used to control pH.
16. Remote communication: Provide open protocol BACnet/IP interface to perform the following functions:
  - a. Access Real-time system values.
  - b. Change operating parameters.
  - c. Controller diagnostics.
  - d. Obtain history files.
  - e. Alarm condition notification.
- D. Provide CPVC injection nozzles, ASTM F441 with corporation stop to inject chemical into main circulating water line.
  1. Pressure rating: 700kPa (100 PSI)
  2. Size: DN20 (3/4 IN) NPT.
  3. Quantity: Three (3).
- E. Provide chemical feed pumps operated by a 115V, 60 cycle, single PH motor.
  1. Provide separate stroke and stroke frequency setting capabilities.
  2. Positive displacement type pump
    - a. Provide with anti-siphon/pressure relief valve installed on pump head which provides anti-siphon protection and aids in priming under pressure.
    - b. Capacity: As determined by Water Treatment Vendor.
    - c. Complete with discharge check valves, foot valves, polyethylene suction and discharge tubing.
  3. Quantity: Provide one pump for each chemical provided.
- F. Bleed-off piping assembly:
  1. Inlet shut-off valve.
  2. Wye strainer.
  3. Strainer blowdown valve.
  4. Throttling valve.
  5. Brass solenoid valve compatible with main control panel.
  6. Assembly shall be sized by Water Treatment Vendor.

- G. Secondary containment spill pallets for chemical drums:
  - 1. Material: Polyethylene.
  - 2. Capacity: 250 L (66 GAL) each.
  - 3. Dimensions each: DN135 (53 IN) length x DN74 (29 IN) wide X DN43 (17 IN) high.
  - 4. Provide each pallet with grating and drain plug.
  - 5. Provide one portable loading ramp.
  - 6. Quantity: Two (2).
- H. Provide liquid level switch assemblies with a CPVC bung hole adapter, ASTM F441, to mount directly into 200 L (55 GAL) chemical drum bung hole.
  - 1. Interface with main control panel.
  - 2. Quantity: Three (3).
- I. Corrosion monitor rack:
  - 1. Materials: Corrosion resistant.
  - 2. Construction: ASME specifications.
  - 3. Number of coupons: four (4).
  - 4. Coupon holders: quick disconnect type.
- J. Provide test kits for monitoring inhibitor levels, total dissolved solids, chlorides, alkalinity and closed system inhibitors.
- K. Provide one (1) year's supply of chemical treatment including quantity of chemicals necessary to chemically treat system to control scale, corrosion and biological fouling. Provide water treatment products that perform the following:
  - 1. Inhibitor to protect against corrosion and scale formation.
  - 2. Two liquid biocides for prevention of slime, bacteria and algae.
  - 3. Chromate based chemical are unacceptable.
  - 4. Water treatment chemicals to remain stable throughout operating temperature range.
  - 5. Are compatible with pump seals and other elements in the systems.
  - 6. Maintain required pH balance to prevent precipitation and/or breakdown of circulating fluid.
  - 7. Where analysis justifies addition of pH control, provide alteration of chemical formulation.
- L. Chemicals: Except for acid, provide sufficient chemicals for start-up and testing and twelve months operation from date of project acceptance.
  - 1. Scale/corrosion inhibitor: Provide a concentrated liquid organic corrosion/scale/ fouling inhibiting formation without phosphates, chromates, zinc and other materials in excess of allowable, local,

- effluent limits. Feed automatically. Maintain residual as determined by water treatment laboratory.
2. Dispersant: Provide a concentrated liquid organic/polyelectrolyte formulation. Feed automatically. Maintain residual as determined by water treatment laboratory.
  3. pH Control: Depending upon local water conditions, provide 60 or 66 degree Baume technical grade, concentrated sulfuric acid for acidic treatment or sodium hydroxide (NaOH) for basic treatment to maintain pH in the range of 7.0 to 8.0 automatically. Provide one initial 47 L (12.5 gallon) carboy of acid or base and one spare carboy of acid or base, if required.
  4. Microbiocides: Provide two different, one oxidizing and one non-oxidizing, concentrated algaecide-biocide formulations containing no heavy metals and which are effective at maximum encountered pH. Alternate solutions as needed to effectuate selective kill without build-up of immunity. Period treatment with a chlorine releasing agent is permissible within allowable, local, effluent limits. Feed automatically. Develop peak concentration and maintain for minimum period as determined by water treatment laboratory.
  5. All chemicals to be acceptable for discharge to sanitary sewer.
- M. Water Analysis: Confirm raw water analysis provided on City of Palo Alto web site. ([www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=21196](http://www.cityofpaloalto.org/civica/filebank/blobdload.asp?BlobID=21196))
- N. Conduct performance test to prove capacity and performance of treatment system.
1. Raw water total hardness, PPM
  2. Concentration cycles
  3. Raw water, pH
  4. System water, pH
  5. Chemical solution used
  6. Acid solution used
  7. Quantity of chemical solution injected into system per cycle
  8. Quantity of acid injected into system per cycle
  9. Make up water required
  10. Waste to drain requirement
- O. Chemical Treatment System Piping and Valves:
1. Schedule 80 CPVC and Fittings. Pipe size shall be 25 mm (1 inch) unless otherwise shown.
  2. Ball Valves: CPVC type.



## **2.4 SUMP CLEANING SYSTEM**

### **A. Centrifugal Solid Separator (existing):**

1. Tie to existing unit piping distribution and controls to allow cleaning of sump basin on new towers.
2. Existing skid mounted assembly consisting of separator, centrifugal pump, basket strainer, solids recovery vessel, pressure gages, all interconnecting piping and valves and UL Listed/NEMA 4X motor starter and controls.
3. Material: The separator shall be fabricated of carbon steel with shell material and head material of 0.135 inch wall or heavier. Maximum operating pressure shall be 10.3 bar (150 psi), unless specified otherwise.
4. Finish: Paint coating shall be acrylic urethane, spray-on.
5. Performance: The removal of solids from a pumped/pressurized liquid system shall be accomplished with a centrifugal-action vortex separator. Solids removal efficiency is principally predicated on the difference in specific gravity between the solids and the liquid. Single pass test performance shall be less than 95% removal of solids 74 microns and larger. Pressure loss shall be between 0.3 - 0.8 Bar (5-12 psi).
6. Purging: Evacuation of separated solids shall be accomplished automatically, employing a timer-activated motorized ball valve. Straight-through valve design, with bronze valve body and stainless steel ball in a Teflon seat. NEMA 4 housing for indoor and outdoor installation. Valve size: 50 mm (2").
7. Provide for required sweeper system piping and nozzles within cooling tower basins to achieve effective solids removal. Minimum 1-gpm per square foot of tower basin. Unit shall be sized for one tower basin and designed to alternate between towers via solenoid valves and timer. Provide all interconnecting piping to basins and all controls and other hardware required for a complete and functional system.
8. Provide a differential pressure sensor interface with DDC system.

## **2.5 EQUIPMENT AND MATERIALS IDENTIFICATION**

- ### **A.**
- Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- #### **A. Delivery and Storage:**
- Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.
- #### **B.**
- Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

- C. Refer to Section 23 21 13 HYDRONIC PIPING for chemical treatment piping, installed as follows:
  - 1. Provide a by-pass line around water meters and bleed off piping assembly. Provide ball valves to allow for bypassing, isolation, and servicing of components.
  - 2. Bleed off water piping with bleed off piping assembly shall be piped from pressure side of circulating water piping to a convenient drain. Bleed off connection to main circulating water piping shall be upstream of chemical injection nozzles.
  - 3. Provide piping for the flow assembly piping to the main control panel and accessories.
    - a. The inlet piping shall connect to the discharge side of the circulating water pump.
    - b. The outlet piping shall connect to the water piping serving the cooling tower downstream of the heat source.
    - c. Provide inlet Y strainer and ball valves to isolate and service main control panel and accessories.
  - 4. Install injection nozzles with corporation stops in the water piping serving the cooling tower downstream of the heat source.
  - 5. Provide piping for corrosion monitor rack per manufacturer's installation instructions. Provide ball valves to isolate and service rack.
  - 6. Provide piping for erosion chemical feeder per manufacturer's installation instructions. Provide PVC ball valves to isolate and service feeder.
  - 7. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.
- D. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.
- E. Do not valve in or operate system pumps until after system has been cleaned.
- F. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.
- G. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. After cleaning is complete, and water PH is acceptable to manufacturer of water treatment chemical, add manufacturer-recommended amount of chemicals to systems.
- I. Instruct VA personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

### **3.2 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -



**SECTION 23 31 00**

**HVAC DUCTS AND CASINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
  - 2. Refer to Section 23 52 35, HEAT RECOVERY STEAM GENERATOR, for ducting and casings specific to HRSG and to Section 26 32 14, COMBUSTION TURBINE GENERATOR, for ducting and casings specific to CTG.
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
  - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
  - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - 4. Exposed Duct: Exposed to view in a finished room or exposed to weather.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS and VENTS.
- E. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT, and Section 23 05 51, NOISE AND VIBRATION CONTROL FOR COGENERATION PLANT.

- H. Duct Insulation: Section 23 07 11, HVAC and COGENERATION PLANT INSULATION
- I. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- J. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.
- K. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- L. Duct Mounted Instrumentation: Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEMS.
- M. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- N. Smoke Detectors: Section 28 31 00, DETECTION and ALARM.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.
- C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access doors.
  - 2. Round and flat oval duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Duct liner.

- c. Sealants and gaskets.
    - d. Access sections.
    - e. Installation instructions.
  3. Volume dampers, back draft dampers.
  4. Upper hanger attachments.
  5. Fire dampers, fire doors, and smoke dampers with installation instructions.
  6. Sound attenuators, including pressure drop and acoustic performance.
  7. Flexible ducts and clamps, with manufacturer's installation instructions.
  8. Flexible connections.
  9. Instrument test fittings.
  10. Details and design analysis of alternate or optional duct systems.
  11. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

## **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE):
1. ASCE7-05 Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
1. A167-99(2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  2. A653-07 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
  3. B209-06 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  4. E1-07 Standard Specification for ASTM Liquid-in-Glass Thermometers

- 5. E77-07 Standard Test Method for Inspection and Verification of Thermometers
- 6. E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
  - 1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - 1. 2nd Edition - 2005 HVAC Duct Construction Standards, Metal and Flexible
  - 2. 1st Edition - 1985 HVAC Air Duct Leakage Test Manual
- F. Underwriters Laboratories, Inc. (UL):
  - 1. 181-08 Factory-Made Air Ducts and Air Connectors
  - 2. 555-06 Standard for Fire Dampers
  - 3. 555S-06 Standard for Smoke Dampers

## **PART 2 - PRODUCTS**

### **2.1 DUCT MATERIALS AND SEALANTS**

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
  - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
  - 2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
  - 3. Gaskets in Flanged Joints: Soft neoprene.
- D. Approved factory made joints may be used.



## **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
  - 1. 0 to 50 mm (2 inch)
  - 2. > 50 mm to 75 mm (2 inch to 3 inch)
  - 3. > 75 mm to 100 mm (3 inch to 4 inch)
  - 4. Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
  - 1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
  - 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
  - 3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
    - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
    - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
  - 4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Resident Engineer.
- E. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.

- F. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- G. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.
- H. Ductwork in excess of 620 cm<sup>2</sup> (96 square inches) shall be protected unless the duct has one dimension less than 150 mm (6 inches) if it passes through the areas listed below. Refer to the Mission Critical Physical Design Manual for VA Facilities. This applies to the following:
  - 1. Agent cashier spaces
  - 2. Perimeter partitions of caches
  - 3. Perimeter partitions of computer rooms
  - 4. Perimeter of a COOP sites
  - 5. Perimeter partitions of Entrances
  - 6. Security control centers (SCC)

### **2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
  - 1. Each duct mounted coil.
  - 2. Each fire damper (for link service), smoke damper and automatic control damper.
  - 3. Each duct mounted smoke detector.
  - 4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
  - 1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
  - 2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

### **2.4 FIRE DAMPERS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.

C. Minimum requirements for fire dampers:

1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
2. Submit manufacturer's installation instructions conforming to UL rating test.

**2.5 SMOKE DAMPERS**

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).
- B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.
- C. Minimum requirements for dampers:
1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
  2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
  3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
  4. Shafts: Galvanized steel.
  5. Bearings: Nylon, bronze sleeve or ball type.
  6. Hardware: Zinc plated.
  7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.
- D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

**2.6 COMBINATION FIRE AND SMOKE DAMPERS**

- A. Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

**2.7 FIRE DOORS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 71 degrees C (160 degrees F) fusible link, 3 hour rating and approved for openings

in Class A fire walls with rating up to 4 hours, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

## **2.8 FLEXIBLE AIR DUCT**

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).
- D. Application Criteria:
  - 1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
  - 2. Maximum working velocity: 1200 m/min (4000 feet per minute).
  - 3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.
- E. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

## **2.9 FLEXIBLE DUCT CONNECTIONS**

- A. Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

## **2.10 SOUND ATTENUATING UNITS**

- A. Casing, not less than 1.0 mm (20 gage) galvanized sheet steel, or 1.3 mm (18 gage) aluminum fitted with suitable flanges to make clean airtight connections to ductwork. Sound-absorbent material faced with glass fiber cloth and covered with not less than 0,6 mm (24 gage) or heavier galvanized perforated sheet steel, or 0.85 mm (22 gage) or heavier perforated aluminum. Perforations shall not exceed 4 mm (5/32-inch) diameter, approximately 25 percent free area. Sound absorbent material shall be long glass fiber acoustic blanket meeting requirements of NFPA 90A.
- B. Entire unit shall be completely air tight and free of vibration and buckling at internal static pressures up to 2000 Pa (8 inches W.G.) at operating velocities.
- C. Pressure drop through each unit: Not to exceed indicated value at design air quantities indicated.
- D. Submit complete independent laboratory test data showing pressure drop and acoustical performance.
- E. Cap open ends of attenuators at factory with plastic, heavy duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuator. Caps shall not be removed until attenuator is installed in duct system.

## **2.11 PREFABRICATED ROOF CURBS**

- A. Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

## **2.12 SEISMIC RESTRAINT FOR DUCTWORK**

- A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

## **2.13 DUCT MOUNTED THERMOMETER (AIR)**

- A. Stem Type Thermometers: ASTM E1, 7 inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:
  - 1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

#### **2.14 DUCT MOUNTED TEMPERATURE SENSOR (AIR)**

- A. Refer to Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.

#### **2.15 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
  1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
  2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
  3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
  4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.

- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.
- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Control Damper Installation:
  - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
  - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
  - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
  - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- I. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both

inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

### **3.2 DUCT LEAKAGE TESTS AND REPAIR**

- A. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.

### **3.3 DUCTWORK EXPOSED TO WIND VELOCITY**

- A. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand wind velocity of 145km/h (90mph).

### **3.4 TESTING, ADJUSTING AND BALANCING (TAB)**

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

### **3.5 OPERATING AND PERFORMANCE TESTS**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC

### **3.6 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.7 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 34 00**

**HVAC FANS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- I. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- J. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- K. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.
- L. Section 26 29 11, MOTOR STARTERS.

**1.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Mechanical equipment and components are to be seismically qualified/certified per ASCE 7-05, Chapter 13, and as clarified in the Office of Statewide Health Planning and Development (OSHPD) Code Application Notice (CAN) No. 2-1708A.5.
- B. Seismic Performance: Active equipment shall be special seismic certified utilizing shake table testing in accordance with ASCE 7-05, Section 13.2.5,

using criteria applicable to IBC Seismic Design Category F. The unit supplied for installation in this Project shall not have been subjected to shake table testing. Testing shall be conducted at nationally recognized test laboratory acceptable to the VA. No alternate method of proving compliance will be accepted for this Project. Components with hazardous components shall be certified by supplier as maintaining containment following the design earthquake analysis or by shake table testing as described above.

- C. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS for additional seismic performance criteria.

#### **1.4 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 261, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
1. Testing and Rating: AMCA 210.
  2. Sound Rating: AMCA 300.
- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- F. Performance Criteria:
1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field.
  2. Select the fan operating point as follows:
    - a. Forward Curve and axial flow fans: Right hand side of peak pressure point.
    - b. Air Foil, Backward Inclined or tubular: At or Near the peak static efficiency.
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- H. Corrosion Protection:
1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.
  2. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20 percent of the Lower

Explosive Limit (LEL), the fan construction shall be as recommended by AMCA's Classification for Spark Resistant Construction. Drive set shall be comprised of non-static belts for use in an explosive.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers Literature and Data:
  - 1. Fan sections, motors and drives.
  - 2. Centrifugal fans, motors, drives, accessories and coatings.
    - a. In-line centrifugal fans.
    - b. Tubular Centrifugal Fans.
    - c. Industrial fans.
  - 3. Prefabricated roof curbs.
  - 4. Centrifugal ceiling fans.
  - 5. Propeller fans.
  - 6. Tube-axial fans.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Roof curbs.
- F. Belt guards.
- G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.
- I. Seismic Qualification: Submit proof of equipment qualification to requirements for Special Seismic Certification. See Seismic Performance Requirements article.
  - 1. Proof of qualification shall consist of certificate issued by testing laboratory, signed by both laboratory representative and equipment manufacturer.
  - 2. Alternate proof of qualification: OSHPD pre-approved equipment with OSHPD OPA number.
- J. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):
  1. 99-86 Standards Handbook
  2. 210-06 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
  3. 261-09 Directory of Products Licensed to bear the AMCA Certified Ratings Seal - Published Annually
  4. 300-08 Reverberant Room Method for Sound Testing of Fans
- C. American Society of Civil Engineers (ASCE):
  1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- D. American Society for Testing and Materials (ASTM):
  1. B117-07a Standard Practice for Operating Salt Spray (Fog) Apparatus
  2. D1735-08 Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
  3. D3359-08 Standard Test Methods for Measuring Adhesion by Tape Test
  4. G152-06 Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials
  5. G153-04 Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

#### **1.7 EXTRA MATERIALS**

- A. Provide one additional set of belts for all belt-driven fans.

### **PART 2 - PRODUCTS**

#### **2.1 CENTRIFUGAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.

- B. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.
1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets without duct connections.
  2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
  3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
  4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
  5. Belts: Oil resistant, non-sparking and non-static. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
  6. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys, so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
  7. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for specifications. Provide protective sheet metal enclosure for fans located outdoors.
  8. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section, MOTOR STARTERS. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for controller/motor combination requirements.
- C. In-line Centrifugal Fans: In addition to the requirements of paragraphs A and 2.2.B3 thru 2.2.B8, provide minimum 18 Gauge galvanized steel housing with inlet and outlet flanges, backward inclined aluminum centrifugal fan wheel, bolted access door and supports as required. Motors shall be factory pre-wired to an external junction box. Provide factory wired disconnect switch.
- D. Tubular Centrifugal Fans: In addition to requirements of paragraphs A and 2.2.B2 thru 2.2.B8 provide;
1. Housings: Hot rolled steel, one-piece design, incorporating integral guide vanes, motor mounts, bolted access hatch and end flanges. Provide spun inlet bell and screen for unducted inlet and screen for unducted outlet. Provide welded steel, flanged inlet and outlet cones for ducted connection. Provide mounting legs or suspension brackets as required for support. Guide vanes shall straighten the discharge air pattern to provide linear flow.

- E. Industrial Fans: Use where scheduled or in lieu of centrifugal fans for low volume high static service. Construction specifications paragraphs A and C for centrifugal fans shall apply. Provide material handling flat blade type fan wheel.
- F. Spark Resistant/Explosion Proof Fans: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), provide AMCA construction option: A, B or C as indicated. Drive set shall be comprised of non-static belts for use in an explosive atmosphere. Motor shall be explosion proof type if located in air stream.

## **2.2 CENTRIFUGAL CEILING FANS (SMALL CABINET FAN)**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Steel housing, baked enamel finish, direct connected fan assembly, attached grille. Provide gravity back draft assembly, aluminum wall cap and bird or insect screen.
- C. Acoustical Lining: 12.5 mm (1/2 inch) thick mineral fiber, dark finish. Comply with UL 181 for erosion.
- D. Motor: Shaded pole or permanent split capacitor, sleeve bearings, supported by steel brackets in combination with rubber isolators.
- E. Ceiling Grille, (Where indicated): White plastic egg crate design, 80 percent free area.
- F. Control: Provide solid state speed control (located at unit) for final air balancing.

## **2.3 PROPELLER FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Belt-driven or direct-driven fans as indicated on drawings.
- C. Square steel panel, deep drawn venturi, arc welded to support arms and fan/motor support brackets, baked enamel finish. Provide wall collar for thru-wall installations.
- D. Motor, Motor Base and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Motor shall be totally enclosed type.
- E. Wall Shutter: Fan manufacturer's standard, steel frame, aluminum blades, heavy duty stall type electric damper motor, spring closed.
- F. Wire Safety Guards: Provide on exposed inlet and outlet.

## **2.4 VANE AXIAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. The requirements for AMCA listing and seal are waived.

- B. Fan Housings: Hot rolled steel, one-piece design, incorporating integral guide vanes, motor mounts, bolted access hatch and end flanges. Provide spun inlet bell and screen for unducted inlet and screen for unducted outlet. Provide welded steel, flanged inlet and outlet cones for ducted connection. Provide mounting legs or suspension brackets as required for support. Guide vanes shall straighten the discharge air pattern to provide linear flow.
- C. Impeller: Heat treated cast aluminum alloy incorporating airfoil blades. Impellers shall be balanced statically and dynamically prior to installation on the shaft and as an integral unit prior to shipment.
- D. Fan Drive: Direct drive or belt drive as scheduled, arrangement 4, with motor located inside fan housing on discharge side of impeller, NEMA C motor mounting, bearings B-10 with average operating life of 200,000 hours, motor wiring leads and bearing lubrication lines extended to outside of housing. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for motor specifications.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### **3.2 PRE-OPERATION MAINTENANCE**

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

#### **3.3 START-UP AND INSTRUCTIONS**

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.

- C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

#### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 37 00**

**OUTLETS AND INLETS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof curbs.
- B. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS AND VENTS.
- E. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- H. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Fire Safety Code: Comply with NFPA 90A.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air intake/exhaust hoods.

2. Diffusers, registers, grilles and accessories.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. LEED Submittals: Submit in accordance with Section 01 81 11.
  1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Diffusion Council Test Code:
  1. 1062 GRD-84 Certification, Rating, and Test Manual 4th Edition
- C. American Society of Civil Engineers (ASCE):
  1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures
- D. American Society for Testing and Materials (ASTM):
  1. B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- E. National Fire Protection Association (NFPA):
  1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems

### **PART 2 - PRODUCTS**

#### **2.1 GRAVITY INTAKE/EXHAUST VENTILATORS (ROOF MOUNTED)**

- A. Aluminum, ASTM B209, louvered, spun, or fabricated using panel sections with roll-formed edges, 13 mm (1/2 inch) mesh aluminum welded wire bird screen, with gravity or motorized dampers where shown, accessible interior, designed for wind velocity specified in Paragraph 3.3.
  1. Spun Intake/Exhaust Ventilators: Spun aluminum structural components shall be constructed of minimum 1.3 mm (16 Gauge) marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength.

2. Low Silhouette Intake/Exhaust Ventilator: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The aluminum hood shall be constructed of minimum 1.60 mm (14 Gauge) marine alloy aluminum, bolted to a minimum 3.25 mm (8 Gauge) aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of 13 mm (1/2 inch) mesh shall be mounted across the relief opening.
- B. See ventilator schedule on the drawings. Sizes shown on the drawings designate throat size. Area of ventilator perimeter opening shall be not less than the throat area.
- C. Dampers for Gravity Ventilators without Duct Connection: Construct damper of the same material as the ventilator and of the design to completely close opening or remain wide open. Hold damper in closed position by a brass chain and catch. Extend chains 300 mm (12 inches) below and engage catch when damper is closed.
- D. Provide Roof Curb by unit manufacturer. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC for additional requirements.

## **2.2 EQUIPMENT SUPPORTS**

- A. Refer to Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

## **2.3 OUTLETS AND INLETS**

- A. Materials:
  1. Steel or aluminum Use aluminum air outlets and inlets for facilities located in high-humidity areas. Exhaust air registers located in combination toilets and shower stalls shall be constructed from aluminum. Provide manufacturer's standard gasket.
  2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
  3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.
- B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT for NC criteria.
- C. Air Supply Outlets:
  1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
    - a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.

- b. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
    - c. Perforated face type: Manual adjustment for one-, two-, three-, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. Perforated face diffusers for VAV systems shall have the pattern controller on the inner face, rather than in the neck and designed to discharge air horizontally at the ceiling maintaining a Coanda effect.
  - 2. Supply Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
    - a. Margin: Flat, 30 mm (1-1/4 inches) wide.
    - b. Bar spacing: 20 mm (3/4 inch) maximum.
    - c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.
  - 3. Supply Grilles: Same as registers but without the opposed blade damper.
- D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
  - 1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
  - 2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
  - 3. Perforated Face Type: To match supply units.
  - 4. Grid Core Type: 13 mm by 13 mm (1/2 inch by 1/2 inch) core with 30 mm (1-1/4 inch) margin.
  - 5. Linear Type: To match supply units.
  - 6. Door Grilles: Are furnished with the doors.
  - 7. Egg Crate Grilles: Aluminum or Painted Steel 1/2 by 1/2 by 1/2 inch grid providing 90% free area.
    - a. Heavy extruded aluminum frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory applied white finish.
    - b. Grille shall be suitable for duct or surface mounting as indicated on drawings. All necessary appurtenances shall be provided to allow for mounting.
- E. Acoustic Transfer Grille: Aluminum, suitable for partition or wall mounting.

**2.4 WIRE MESH GRILLE**

- A. Fabricate grille with 2 x 2 mesh 13 mm (1/2 inch) galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately 40 mm (1-1/2 inch) margin.
- B. Use grilles where shown in unfinished areas such as mechanical rooms.

**PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

**3.2 INTAKE/ EXHAUST HOODS EXPOSED TO WIND VELOCITY**

- A. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand wind velocity of 145 km/h (90 mph).

**3.3 TESTING, ADJUSTING AND BALANCING (TAB)**

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

**3.4 OPERATING AND PERFORMANCE TESTS**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC

**3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

**3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 40 00**

**HVAC AIR CLEANING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE Standard 52.2 for definitions of face velocity, net effective filtering area, media velocity, initial resistance (pressure drop), MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency), particle size ranges for each MERV number, dust holding capacity and explanation of electrostatic media based filtration products versus mechanical filtration products. Refer to ASHRAE Standard 52.2 Appendix J for definition of MERV-A.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.

**1.3 QUALITY ASSURANCE**

- A. Air Filter Performance Report for Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standard 52.2 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. Filters utilizing partial or complete synthetic media will be tested in compliance with pre-conditioning steps as stated in Appendix J. All testing is to be conducted on filters with a nominal 24 inch by 24 inch face dimension. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.
  - 2. Government Option: The Government at its option may take one of the filters for each different type submitted and run an independent test to determine if the filter meets the requirements of this

specification. When the filter meets the requirements, the Government will pay for the test. When the filter does not meet the specification requirements, the manufacturer will be required to pay for the test and replace the filters with filters that will perform as required by the specifications.

3. **Guarantee Performance:** The manufacturer shall supply ASHRAE 52.2 test reports on each filter type submitted. Any filter supplied will be required to maintain the minimum efficiency shown on the ASHRAE Standard 52.2 report throughout the time the filter is in service. Within the first 6-12 weeks of service a filter may be pulled out of service and sent to an independent laboratory for ASHRAE Standard 52.2 testing for initial efficiency only. If this filter fails to meet the minimum level of efficiency shown in the previously submitted reports, the filter manufacturer/distributor shall take back all filters and refund the owner all monies paid for the filters, cost of installation, cost of freight and cost of testing.
- B. **Filter Warranty for Extended Surface Filters:** Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no cost to the Government.
- C. **Comply with UL Standard 900 for flame test.**
- D. **Nameplates:** Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency, UL classification, and file number.

#### **1.4 SUBMITTALS**

- A. **Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.**
- B. **Manufacturer's Literature and Data:**
  1. Extended surface filters.
  2. Holding frames. Identify locations.
  3. Side access housings. Identify locations, verify insulated doors.
  4. Magnehelic gages.
- C. **Air Filter performance reports.**
- D. **Suppliers warranty.**
- E. **LEED Submittals:** Submit in accordance with Section 01 81 11.01.
  1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. **LEED Product Data Submittal Form:** Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.



## 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):
  - 1. Standard 52.2-2007 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, including Appendix J
- C. Underwriters Laboratories, Inc. (UL):
  - 1. 900;Revision 15 July 2009 Test Performance of Air Filter Units

## PART 2 - PRODUCTS

### 2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS, provide one complete set of spare filters to the Resident Engineer.
- B. The Resident Engineer will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.

### 2.2 EXTENDED SURFACE AIR FILTERS

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the contaminant load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL listed and approved conforming to UL Standard 900.
- C. HVAC Filter Types (Where not specified in other Sections):

HVAC Filter Types Table 2.2C				
MERV Value ASHRAE 52.2	MERV-A Value ASHRAE 62.2 Appendix J	Application	Particle Size	Thickness /Type
8	8-A	Pre-Filter	3 to 10 Microns	50 mm (2-inch) Throwaway

### 2.3 MEDIUM EFFICIENCY PLEATED PANEL PRE-FILTERS (2"; MERV 8; UL 900 CLASS 2):

- A. Construction: Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic or 100% virgin synthetic media, self supporting media with required media stabilizers, and beverage board enclosing frame. Filter media shall be lofted to a uniform depth and formed into a uniform radial pleat. The media stabilizers shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.
- B. Performance: The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2. It shall also have a MERV-A of 8 when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24" x 24" face dimension.

Minimum Efficiency Reporting (MERV)	8
Dust Holding Capacity (Grams)	105
Nominal Size (Width x Height x Depth)	24x24x2
Rated Air Flow Capacity (Cubic Feet per Minute)	2,000
Rated Air Flow Rate (Feet per Minute)	500
Final Resistance (Inches w.g.)	1.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.66
Rated Initial Resistance (Inches w.g.)	0.33

- C. The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to U. L. Standard 900 and CAN 4-5111.

### 2.4 FILTER HOUSINGS/SUPPORT FRAMES

- A. Side Servicing Housings (HVAC Grade)
1. Filter housing shall consist of 16-gauge galvanized steel enclosure, aluminum filter mounting track, universal filter holding frame, insulated access doors, static pressure tap, filter gaskets and seals.
  2. Construction: The housing shall be constructed of 16-gauge galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components. Corner posts of Z-channel construction shall ensure dimensional adherence. A filter track, of aluminum

construction shall be an integral component of housing construction. Insulated dual access door, swing-open type, shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges.

## **2.5 INSTRUMENTATION**

- A. Magnehelic Differential Pressure Filter Gages: Nominal 100 mm (four inch) diameter, zero to 500 Pa (zero to two inch water gage).
- B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 23 FACILITY MONITORING AND CONTROL SYSTEMS.
- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.

## **2.6 HVAC EQUIPMENT FACTORY FILTERS**

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are not permitted.
- C. Automatic Roll Type filters are not permitted.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION**

- A. Install supports, filters and gages in accordance with manufacturer's instructions.
- B. Label clearly with words "Contaminated Air" on exhaust ducts leading to the HEPA filter housing.

## **3.2 START-UP AND TEMPORARY USE**

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.
- B. Install or deliver replacement filter units as directed by the Resident Engineer.

## **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

#### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -

**SECTION 23 50 11**

**COGENERATION PLANT MECHANICAL EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Condensate and HRSG feed pumps, condensate receiver/pump unit, receiver, compressed air systems, blow down separator and after cooler flash tank economizer, chemical treatment systems, steam vent silencer, and other equipment that supports the operation of the HRSG.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 09 91 00, PAINTING.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.
- G. Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.
- H. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.
- I. Section 23 22 23, STEAM CONDENSATE PUMPS.
- J. Section 22 31 11, WATER SOFTENERS.
- K. Section 25 60 00, CHP PLANT CONTROL SYSTEM.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Flash Tank Economizer Accessories:
  - 1. Drawings showing arrangement and overall dimensions of pumps, receiver and supports. Show locations and sizes of all pipe connections and access openings.
  - 2. Weight of entire assembly empty and flooded.

3. Design and construction (including pressure and temperature limitations) of receiver, continuous blowdown heat exchanger (if provided), control valves, water level control system, level alarm switches and all accessories.
  4. Performance data on control valves and continuous blowdown heat exchanger (if provided). Refer to drawings (Schedules) for requirements.
  5. Interior Coating: Material specification, service limitations, instructions for application, experience record under the required service conditions.
  6. Continuous blowoff heat exchanger tube bundles: Dimensions, design, construction, heating surface, performance data.
- C. Blow Down Separator and After Cooler:
1. Drawing showing outline dimensions, arrangement and weight of tank and accessories. Locations and sizes of all pipe connections and access openings.
  2. Design and construction of tank, supports and accessories.
  3. Design and performance of blowoff tank temperature control valve.
- D. Boiler Feed Pumps:
1. Drawings with dimensions of assemblies of pumps and drivers.
  2. Catalog data and specification sheets on design and construction of pumps, drivers and couplings (flexible-coupled units).
  3. Motor efficiency and power factor at full load.
  4. Performance curves showing discharge head, required flow plus recirculation, NPSH required, efficiency, driver power, impeller diameter to be furnished. Refer to drawings for requirements.
  5. Pressure and temperature limitations of pump unit and accessories.
  6. Size and capacity of recirculation orifice.
  7. Data on variable frequency drive units and pressure controllers (if VFD specified).
- E. Compressed Air System:
1. Drawing with dimensions and arrangement of air compressor, motor, air dryer, receiver and all accessories.
  2. Catalog data and specification sheets on the design and construction of air receiver, compressor, after-cooler, motor, air dryer, all accessories, condensate traps. Solenoid valves and filters.
  3. Performance data on compressors, after coolers, air dryer, relief valves.
- F. Steam Vent Silencer (Muffler):
1. Drawings with silencer dimensions and weights, and sizes and types of pipe connections.

2. Catalog data and specification sheets on the design and construction.
  3. Sound attenuation data at required flow rates.
- G. Automatic Continuous Blowdown Control System:
1. Drawings with arrangement and dimensions of entire unit. Include locations and sizes of all pipe connections.
  2. Catalog data and specification sheets on design and construction of conductivity sensor, control valves, controller.
  3. Performance data on control valves.
  4. Pressure and temperature limitations of valves and conductivity sensor.
- H. Test Data - Acceptance Tests, On-Site: Four copies all specified tests.
- I. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- J. Seismic Restraint Data: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- K. LEED Submittals: Submit in accordance with Section 01 81 11.01.
1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A53/A53M-07 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
  2. A106/A106M-08 Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
  3. A234/A234M-10 Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
  4. A285/A285M-03(2007) Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate - Tensile Strength

5. A414/A414M-10 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy for Pressure Vessels
  6. A515/A515M-03(2007) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-temperature Service
  7. A516/A516M-06 Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
- C. American Society of Mechanical Engineers (ASME):
1. Boiler and Pressure Vessel Code: 2007 Edition with Amendments.
  2. Section VIII Pressure Vessels, Division I and II. Performance Test Code:
  3. PTC 12.3-1997 Performance Test Code for Deaerators
  4. B16.9-2007 Factory-Made Wrought Butt Welding Fittings
  5. B16.34-2009 Valves, Flanged, Threaded and Welding End
- D. National Board of Boiler and Pressure Vessel Inspectors:
1. NB-23-2007 Inspection Code
- E. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
1. ASHRAE Handbook 2008 HVAC Systems and Equipment

## **PART 2 - PRODUCTS**

### **2.1 FLASH TANK ECONOMIZER**

- A. General:
1. Furnish packaged flash tank coil type heat exchanger system, designed to handle a maximum blow down rate of 20 gpm and a maximum makeup rate of 100 gpm.
  2. The system shall be designed for HRSG of the capacity and operating limits as scheduled, minimum. The unit shall be designed to cool the blow down to within 30 deg F of the makeup water temperature. The unit shall have a 150 psig rating at 365 deg F.
  3. The system's flash tank shall have an ASME code design pressure of 150 psig and an internal flash pressure of 5-15 psig. The flash tank shall be complete with a tangential blow down inlet, stainless steel wear plate, steam outlet, ball type float trap with all working parts constructed of stainless steel, tank stand, brass-bodied site glass, and a safety relief valve set at 150 psig. The flash tank shall have a flanged bottom section for quick access to the sludge area and to the coil.
  4. The system shall also have a vertical coil-type heat exchanger. The exchanger shall be constructed of stainless steel and shall be integral with the flash tank. The coil shall be complete with threaded connections for the makeup water inlet and outlet.



5. A gauge panel shall be furnished and shall include dial thermometers for indicating makeup inlet temperature, makeup outlet temperature and blow down outlet temperature. The gauge panel shall be pre-piped and mounted on the unit.
  6. The entire system shall be supported by steel legs with 3/4 inch diameter holes for customer-supplied 1/2 inch diameter bolts. The system will be painted with rust proof coating.
- B. Provide with the following additional features and components:
1. Drain Valve and Level Control
  2. Sample Coolers and Assembly
  3. Flow Control Valve and Assembly
  4. Safety Valve
  5. Gauge Glass
  6. Pressure Gage
  7. Gauge Panel
  8. Level Alarm
  9. Level Alarm Control Panel - Provide signals to PLC control system
  10. Thermometers for exchanger operation
- C. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC and COGENERATION PLANT INSULATION.

## **2.2 BLOW DOWN SEPARATOR**

- A. Type: Centrifugal type constructed of cylindrical stamped or welded steel tank mounted vertically. Tank shall include accessory equipment and shall be suitable for rigging into the available space. Overall dimensions and arrangement of the tank and accessories shall conform to the drawings if noted. Tank sizes shall be as indicated and vent sized for a maximum of 5 psig in separator and after cooler.
- B. Service: Suitable for venting, cooling and discharging into the drain the effluent from the boilers resulting from the intermittent operation of the boiler bottom blowoffs, boiler accessory drains, and the use of continuous blowdowns.
- C. Construction:
1. Construct tank and appurtenances in accordance with ASME Boiler and Pressure Vessel Code, Section VIII. Tank shall have cylindrical shell and dished heads.
  2. Material of construction shall be carbon steel ASTM A285, A414, A515 or A516.
  3. Design tank for 275 kPa (40 psi) working pressure; the minimum material thickness shall be 10 mm (3/8-inch). Thickness of head material at any point shall not vary more than 10 percent from the nominal thickness.

4. All tank joints shall be double-welded butt joints or single-welded butt joints with backing strips.
5. Provide 10 mm (3/8-inch) thick stainless steel wear plate welded to interior of tank adjacent to tangential blowoff inlet as shown.
6. Provide nozzles for piping connections and provide tangential blowoff inlet located above the normal water level. Tangential pipe for blowoff inlet shall be Schedule 80, ASTM A53 or A106, seamless steel pipe with beveled end for field-welding of blowoff from boilers. All other nozzles shall have threaded pipe connections for pipe sizes 50 mm (2 inches) and under, 1025 kPa (150 psi) ASME flanged connections for pipe sizes over 50 mm (2 inches). Nozzle sizes listed below are based on "National Board" recommendations.
7. The inlet connection on the separator must match the HRSG blow-off valve size.

Boiler Blowoff	Water Outlet	Vent
25(1)	25(1)	63(2.5)
32(1.25)	32(1.25)	80(3)
38(1.5)	38(1.5)	100(4)
50(2)	50(2)	130(5)
64(2.5)	64(2.5)	64(6)

8. Furnish completed ASME Form U-1 or U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS. Hydrostatically test tank at 1.3 times the design pressure.
  9. Tank nameplate shall be affixed to bracket which projects beyond the tank insulation that will be applied in the field. Apply ASME data stamp to nameplate to show compliance with design, construction and inspection requirements of the Code.
  10. Support tank by steel legs welded to shell of tank. Design saddles or legs to support tank (full of water), accessories, and portions of connecting piping to first hanger.
- D. Cleaning and Painting: Remove all dirt, heavy rust, mill scale, oil, welding debris from interior and exterior of tank. Prime exterior of tank with rust-resisting paint (See Section 09 91 00, PAINTING).
- E. Insulation: Field apply insulation as specified in Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION.
- F. Accessories:
1. Install red line type gage glasses with protecting rods. Provide off set type gage valves with ball-check feature to automatically prevent flow when glass is broken. Provide drain cock on lower gage valve. Glass shall be at least 300 mm (12 inches) long and centered at the overflow level.

2. Provide thermometer and pressure gage. Conform to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR COGENERATION PLANT.
3. Water Outlet Temperature Control Valve:
  - a. Type: Self-contained, reverse-acting thermal bulb-operated water flow control valve.
  - b. Performance: Control valve shall operate automatically to control blowoff tank water outlet temperature to 60 °C (140 °F) maximum by regulating the flow of cold water which mixes with the blowoff water and reduces the temperature of the blow-off water. Provide valve designed for modulating and tight shut-off service. Valve flow rates and pressure drops shall be as shown. Temperature control range shall be adjustable, 38 to 77 °C (100 to 170 °F) minimum.
  - c. Service: Provide valve designed to control the flow of city water with temperature 4 to 27 °C (40 to 80 °F), and pressure up to 690 kPa (100 psi). Thermal bulb will be inserted in blowoff tank outlet pipe and will be subjected to water temperatures up to 100 °C (212 °F).
  - d. Construction: Cast iron or bronze valve body designed for 850 kPa (125 psi) minimum WOG. Design of valve shall permit access to internal valve parts. Thermal bulb shall be separable socket type with well.
4. Provide blowoff water outlet pipe inside tank as shown to provide a water seal. Locate a 20 mm (3/4-inch) hole in top of this pipe inside tank to act as siphon breaker.

### **2.3 CENTRIFUGAL MULTI-STAGE BOILER FEEDWATER PUMPS**

- A. Type: Two or more stages, centrifugal diffuser type, direct-coupled, vertical shaft, in-line, base-mounted, motor-driven, arranged as shown.
- B. Service: Design pumps and accessories for continuous service, 116 °C (240 °F) water, with flow rates ranging from maximum scheduled on the drawings (plus manufacturer's recommended recirculation) to 10 percent of maximum (plus manufacturer's recommended recirculation). Pumps shall be suitable for parallel operation without surging or hunting.
- C. Performance: Refer to schedules on drawings. Pump head-flow performance curve shall slope continuously upward to shut-off.
- D. Control - Boiler (HRSG) Feed: Flow rates will be controlled by automatic modulating feedwater valves on each HRSG. Pumps shall have variable frequency drives controlled by HRSG feed header pressure electronic control system which must be provided. Control the header pressure at value required by HRSG manufacturer. For VFD requirements refer to Section 26 29 11, MOTOR STARTERS.
- E. Construction:
  1. Rotating elements shall be designed and balanced to conform to sound and vibration limits specified in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

2. Mechanical seals shall have sealing face materials of carbon and tungsten or silicon carbide.
  3. Design bearings for two-year minimum life with continuous operation at maximum pump operating load. Bearings and shaft seals shall be water-cooled if recommended by pump manufacturer for the service.
  4. Materials of Construction:
  5. Chambers: Stainless steel
  6. Impellers: Stainless steel
  7. Diffusers: Stainless steel
  8. Shaft: Stainless steel
  9. Suction-Discharge Chamber: Cast iron or stainless steel
- F. Recirculation Orifice: Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from overheating at shut-off and designed for low noise under the service conditions. Orifices must not exceed sound level limits in Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.
- G. Spare Parts: Provide complete rotating assembly for each pump size and type suitable for field installation by plant personnel. Assembly shall include impellers, diffusers, chambers, shaft, seals, bearings.
- H. Shaft Couplings: Pump manufacturers standard. Provide coupling guard.
- I. Electric Motor Drives: High efficiency type, open drip proof. Select motor size so that the motor is not overloaded at any point on the pump head-flow performance curve. Design motor for 40 °C ambient temperature. For efficiency and power factor requirements refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- J. Interface with Computer Workstation: Provide devices to signal computer work station that motor is on or off.

#### **2.4 COMPRESSED AIR SYSTEM**

- A. Provide complete compressed air system to provide shop (cleaning and maintenance) air and to serve controls and instruments. Compressed air systems shall include compressors, motor drives, receivers, aftercoolers, filters, air dryers and accessories as scheduled, as shown on the drawings and as specified.
- B. Compressors:
1. Type: Rotary-screw, air-cooled, intercooled, variable-speed drive.
  2. Performance: Shall be as shown on the drawings. Shall be suitable for continuous service.
  3. Construction:
    - a. Lubrication: Splash type with low oil level automatic shutdown switch, or pressure type with low oil pressure automatic shutdown switch.

- b. Unloading: Provide automatic cylinder air pressure unloader to prevent compressor starting under load.
  - c. Inlet Filter: Dry-type with replaceable cartridge.
  - d. Cylinders: Shall be removable from crankcase.
- C. Receivers: Horizontal cylindrical tanks as shown on the drawings. Construct in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, with inspection under the rules of the National Board of Boiler and Pressure Vessel Inspectors. Design pressure 1025 kPa (150 psi) minimum.
- D. Compressor and Receiver Accessories:
  - 1. Water-cooled Aftercooler: Provide one for each compressor, designed to cool the compressor output air to within 7 °C (10 °F) of the cooling water temperature. Mount on or adjacent to compressor. Provide cooling water solenoid control valve. Valve shall automatically open when compressor starts and close when compressor stops.
  - 2. Automatic Condensate Traps: Provide on lowest point of receiver and on aftercooler if required by type of aftercooler furnished. Size shall be suitable for compressor air delivery.
  - 3. Safety Valve: Provide on receiver, set pressure lower than receiver design pressure. Capacity of valve at set pressure shall be greater than maximum output of all compressors supplying receiver.
  - 4. Pressure Gauges: Provide on receiver and as shown. Refer to specification Section 23 09 11, INSTRUMENTATION and CONTROL FOR COGENERATION PLANT.
  - 5. Receiver Piping Connections: Shall include air in, air out, safety valve, automatic drain, valved manual drain and valved pressure gauge.
- E. Compressor Controls:
  - 1. Compressors Serving Boiler Plant Controls or Instruments: Compressor package shall include an integral, industrial programmable logic controller (PLC), with LCD display, touchpad for local control and set point adjustment. The PLC controller shall feature Ethernet and/or Modbus communications link capabilities in order to interface with plant supervisory control and data acquisition (SCADA) and human machine interface (HMI) system. The communications link shall enable full start/stop, set point adjustment and alarm reporting functionality for the compressor package at the operators workstation and remotely. Refer also to Section 25 60 00, CHP Control System.
  - 2. Controls shall operate on 120 volts maximum. Provide "on-off-automatic" control for each compressor.
- F. Electrical Motors and V-Belt Drives: Motors shall be open drip proof designed for 40 °C ambient temperature. Select V-belt drives in accordance with manufacturer's recommendations for frequent start-stop service. Provide belt guard that encloses belts on all sides.
- G. Vibration Isolation: Refer to specification Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS for isolators required in piping.

- H. Air Dryer: Shall be refrigerant-type with capacity sufficient for all pneumatic controls and instruments in the cogeneration plant. Cycling type which turns on and off in response to load. Base capacity ratings on 690 kPa (100 psi) inlet pressure; 38 °C (100 °F) air inlet temperature; 38 °C (100 °F) ambient air temperature. Unit shall maintain dewpoint at 2 to 4 °C (35 to 40 °F) at 690 kPa (100 psi) air pressure. Provide unit with "power on" light, automatic water drain trap. Provide reheat of output air by heat exchange with input air to decrease condensation on air pipes. Design unit for 1025 kPa (150 psi).
- I. Air Filter: Located in compressed air line between receiver and air dryer, coalescing type, designed to remove oil, entrained water mist, and dirt from the compressed air. Provide automatic drain valve piped to nearest drain. Size unit for maximum pressure drop of 3.5 kPa (0.5 psi) at normal air flow rate. Design unit for 1025 kPa (150 psi) air pressure.
- J. Spare Parts:
  - 1. Complete set of drive belts.
  - 2. Two filter cartridges for each compressor intake filter.
  - 3. Two filter cartridges for air dryer intake filter.

## **2.5 STEAM VENT SILENCER (MUFFLER)**

- A. Type: Residential quality designed to attenuate low and high frequency sound generated by steam vented through a globe valve from a high pressure header.
- B. Service and Performance: Shall be capable of entire maximum steam output of the cogeneration/HRSG plant with superheated steam flowing through the silencer at 100 kPa (14.7 psi), 150 °C (300 °F). Steam in header will be 99.0 to 99.5 percent quality. Venting through globe valve to silencer will cause super-heating and pressure drop to near atmospheric. Unit will be a permanent installation and will be utilized to create steam loads to allow burner adjustments and boiler tests. Pressure loss through unit shall be low. Required attenuation listed below is the insertion loss. No credit is permitted for air absorption at the outlet.
- C. Minimum attenuation:
  - 1. 12 dB minimum at 63 Hz
  - 2. 17 dB minimum at 125 - 250 Hz
  - 3. 25 dB minimum at 250 - 500 Hz
  - 4. 34 dB minimum at 500 - 8000 Hz
- D. Construction: Construct unit of steel with glass fiber or metallic wool acoustical packing. Protect glass fiber acoustical material from damage in high fluid impact areas. Line entire outer shell internally with acoustical material. Provide 104 kPa (150 psi) ANSI inlet and outlet flanges as shown on the drawings. Where flanges are not shown, provide butt weld connections.

## **2.6 BOILER WATER AND DEAERATOR WATER SAMPLE COOLERS**

- A. Type: Factory-built shell and coiled tube heat exchanger with sample in tube, cooling water in shell, designed for wall mounting.
- B. Construction:
  - 1. Shell and Head: Iron, steel or stainless steel shell, bolted or threaded into head. Head shall have wall mounting brackets and piping connections for sample in and out and cooling water out. Minimum design pressure for shell and head, 1025 kPa (150 psi). Shell removable without disturbing piping connections.
  - 2. Sample Coil: Shall be 6 mm (1/4-inch) outside diameter stainless steel tubing, 0.11 square meter (1.2 square feet) minimum heat exchange surface. Minimum design for 1025 kPa (150 psi), 188 °C (370 °F). Design coil to relieve stresses due to thermal expansion.
  - 3. Arrangement: Shall be as shown on the drawings.

## **2.7 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM**

- A. Type: One factory-assembled system per boiler to automatically sense boiler water conductivity and operate automatic electric-powered blowdown valve to maintain desired total dissolved solids content in boiler water. Micrometer-type adjustable manual blowdown valve piped to bypass the automatic blowdown valve and conductivity sensor.
- B. Service: Design valves, sensors and piping for steam and water at 1035 kPa (150 psi), 186 °C (366 °F) minimum. Controller shall be suitable for 50 °C (120 °F) ambient and resist splashing water. Design automatic and manual blowdown valves for maximum blowdown flow rate equivalent to two percent of boiler steam output. System shall automatically maintain boiler water total dissolved solids at any set point between 1000 ppm and 4000 ppm.
- C. Operation: Programmable timer cycles to intermittently operate the blowdown valve to obtain conductivity samples, and to maintain the valve open for a time period until the conductivity of the boiler water reaches the set point. Provide an automatic temperature compensating circuit.
- D. Controller: Shall be microprocessor-based sealed unit mounted at the boiler.
  - 1. Indicators on Panel Front: One-half inch high digital display showing conductivity and indicating normal or out-of-range conditions. Valve status indicators.
  - 2. Membrane Keypad on Panel Front: Allows manual operation of the blowdown valve, setting of conductivity set points and alarm set points, setting of timers, calibration data input.
- E. Automatic Valve Construction: Carbon steel body, Type 316 stainless steel ball and stem, TFE coated stainless steel body seal. Electric actuator with NEMA-1 enclosure. Rated for 1025 kPa (150 psi) minimum saturated steam.

- F. Manual Valve Construction: Bronze or forged steel angle-type body, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Rated for 1025 kPa (150 psi) minimum saturated steam. Furnish valve blowdown chart showing flow rate versus valve opening based on 125 psi boiler pressure.
- G. Provide gate valves and unions at inlet of conductivity sensor and outlet of automatic control valve so that these items can be removed from the system while maintaining the manual control valve in service. Comply with Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Feedwater Deaerator with Storage Tank and Accessories, Condensate Storage Tank, Blowoff Tank, Flash Tank.
  - 1. Coordinate location with structural requirements of the building.
  - 2. Location shall permit access to and removal of all internal and external features without removing other items of equipment or piping.
  - 3. Bolt to building as recommended by manufacturer or as shown. Comply with seismic requirements in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Arrange anchorage to allow thermal expansion of unit.
  - 4. Clean interior of equipment before placing in service.
  - 5. Deaerator vent pipes must extend vertically through roof. Horizontal runs not permitted.
  - 6. All controls, safeties, set points, etc must conform to the most recent edition of the VHA Boiler Plant Safety Device Testing Manual.
- B. Boiler Feed Pumps:
  - 1. For base-mounted horizontal-shaft pumps, connect base drain to 20 mm (3/4-inch) pipe. Extend pipe to nearest open sight or floor drain.
  - 2. Align pumps and drivers at the factory. At job site, a millwright shall level, shim, bolt, and grout the base plates or base frames onto the concrete pads, and shall also check the alignments of flexible-coupled pumps and drivers and make corrections necessary. Check alignment when both pump and driver are at normal operating temperature.
  - 3. Where packaged deaerator-feed pump unit is required, boiler feed pump base plates shall be welded or bolted to deaerator support frame.
  - 4. If water-cooled bearings or quenched or flushed or water-cooled stuffing boxes are provided on pumps, contractor shall install on each pump valved 15 mm (1/2-inch) piping connections to cold water supply, and 15 mm (1/2-inch) drains to nearest open sight drain. Provide unions at all connections to pumps.



- C. Compressed Air System: Pipe all drain connections individually to nearest floor drain. Use 15 mm (1/2-inch) piping. Provide union at each drain connection on the equipment.
- D. Automatic Continuous Boiler Blowdown Control System: Locate controller on floor-supported angle at four feet above the floor at the boiler adjacent to the continuous blowdown valves. Keypad and indicator must face aisle.

### **3.2 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct each VA personnel responsible in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 51 00**

**BREECHINGS, CHIMNEYS, AND STACKS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies flue gas exhaust system and all accessories for the gas fired water heater and the generator exhaust not furnished as part of Section 26 32 13, ENGINE GENERATORS. All flue gas exhaust from bellows connection on combustion turbine generator outlet through the Heat Recovery Steam generator to atmosphere is covered under Section 23 52 35, HEAT RECOVERY STEAM GENERATOR.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 07 60 00, FLASHING and SHEET METAL: Roof Penetrations.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS,
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.
- H. Section 23 07 11, HVAC, PLUMBING, and COGENERATION PLANT INSULATION.
- I. Section 23 52 35, HEAT RECOVERY STEAM GENERATORS: Economizers

**1.3 QUALITY ASSURANCE**

- A. Provide scale drawings showing nominal dimensions and weight of the systems.
- B. If a double wall, factory-fabricated, positive pressure breeching and stack system is provided, the manufacturer shall completely engineer the entire system and provide all components. Manufacturer's representative shall provide installation instructions prior to start of construction, train the installers and certify in writing to the Resident Engineer (RE) that the entire installation complies with the official standards of the manufacturer and with the project specifications.

- C. Conform to NFPA 54 and NFPA 31 for installation of fuel burning equipment and appliances.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- C. Design, materials, weights, construction, pressure and temperature limitations of breeching and stack systems. Seismic design data.
- D. Drawings showing all components, system arrangement and dimensions.
- E. Design, construction, allowable movements, movement forces, pressure and temperature limitations of expansion joints.
- F. Damper design, construction, pressure and temperature limitations, pressure loss at design flow, and leakage of closed damper.
- G. Support designs, locations and loads for entire assembly. Seismic design data.
- H. Written statement from gas turbine generator/HRSG/duct burner manufacturers, that the design of the system is satisfactory to achieve the required boiler/burner performance.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Institute of Steel Construction (AISC):
  - 1. Steel Construction Manual, Thirteenth Edition
- C. ASTM International (ASTM):
  - 1. A568/A568M-09a Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements For
- D. American Welding Society (AWS):

1. D1.1/D1.1M-2010 Structural Welding Code-Steel
- E. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
  1. SP-58-2009 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
- F. National Fire Protection Association:
  1. NFPA 54-2009 National Fuel Gas Code
  2. NFPA 31-2006 Standard for the Installation of Oil-Burning Equipment
  3. NFPA 211-2010 Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances

## **PART 2 - PRODUCTS**

### **2.1 BREECHING AND STACKS**

- A. Refer to drawings for arrangement and dimensions. Connections to equipment must comply with the written recommendations of the manufacturers. Ninety-degree tee sections are not permitted. Intersections must be made with lateral tees.
- B. Service: For engine exhaust design for continuous 760 °C (1400°F), 12 kPa (50 inches WC) positive and negative internal pressure, wind-loading for outside stacks 95 mph. Design system and supports for seismic loads in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Pre-engineered, Pre-Fabricated, Double-Wall System:
  1. Complete factory-built system, all components and installation engineered and provided by manufacturer of system.
  2. Provide double wall metal stacks, tested to [UL 103] ] and UL listed, for use with building heating equipment, in compliance with NFPA 211.
  3. Corrosion-resistant steel, double-wall, circular cross section, positive pressure, blanket insulation between walls. For stack sections outside the building, air space with no insulation between walls is allowed except in areas accessible to personnel including platforms.
  4. Factory-built standard sections, connected in the field with joining system designed and provided by system manufacturer. Designed to be pressure and vacuum-tight, no deformation, at the service conditions specified.
  5. System manufacturer's engineered support system, attached to structural members of the building, with expansion joints between rigid supports. Thermal expansion shall be handled by expansion joints and variable spring hangers. Thermal expansion and weight of system shall not impose loads in excess of that allowed by manufacturer of boiler, economizer, or any other equipment, or exceed capabilities

- of building structure. Spring hangers shall conform to MSS SP-58, Type 51, variable spring.
6. UL-listed for required clearance to combustible materials and required clearance to non-combustible materials.
  7. Inner Wall: Stainless steel, Type 304, 0.9 mm (0.035-inch) minimum thickness for diameters 900 mm (36 inches) and smaller and 1.2 mm (0.048 inches) minimum thickness for diameters greater than 900 mm (36 inches) and 1200 mm (48 inches) and less.
  8. Outer Wall: Aluminized or galvanized steel except 304 stainless steel outside of building, 0.6 mm (0.025 inch) minimum thickness for inner wall diameter 800 mm (32 inches) and less, 0.9 mm (0.034 inch) minimum thickness for inner wall diameter over 800 mm (32 inches) and 1200 mm (48 inches) and less.
  9. Uninsulated Air Space between Inner and Outer Walls (Outside the Building Only): 25 mm (one inch) minimum.
  10. Insulation Between Walls: Fiberglass or mineral wool, 315 °C (600 °F). Minimum thickness 50 mm (2 inches).
  11. Bands for Joining Sections: Same material as section being joined. Utilize sealant provided by system manufacturer.
  12. Roof and wall penetrations shall be manufacturer's standard ventilated thimble. Conform to Section 07 60 00, FLASHING and SHEET METAL.
  13. Stack Outlet: Provide as shown, double cone rain cap or other type termination designed by manufacturer of the stack system.
  14. Drain Section: Provide inside building below roof to drain rain water from stack. Extend drain pipe to floor drain.
  15. Guys: Provide stack guy wires above roof, with spring-loaded tensioners, in accordance with printed instructions of stack manufacturer.

## **2.2 EXPANSION JOINTS**

- A. Provide sufficient types, quantities, and locations of expansion joints to completely absorb all thermal expansion of the system without imposing excessive loads on equipment or building structure. Fabric joints shall be used on single-wall stack and breeching system. On factory-fabricated double wall stack or breeching system, use slip-type, bellows-type, or fabric expansion joints engineered by designer of the stack and breeching system.
- B. Service: Design for 300 °C (575 °F), 5 kPa (20 inches) WC positive and negative internal pressure, continuous duty.
- C. Construction, Fabric Joints:
  1. Fabric: High strength, designed for dewpoint service.
  2. Internal Baffles: Carbon steel with stiffeners. Designed to protect interior surfaces of fabric from wiping action of the flue gases.

3. Welded frame, 6 mm (1/4 inch) thick ASTM A568 steel with 100mm (4 inch) minimum flange height, flat-belt design, fabricated by expansion joint manufacturer. Fabric element bolting, 9 mm (3/8 inch) diameter, 150 mm (6 inch) maximum centers.

D. Construction, Factory-Fabricated Double-Wall System Joints:

1. Materials: Same as factory-fabricated breeching system.
2. Packing Gland: High temperature rating. Provide seal between sliding and fixed portions of joint.

## **2.3 ACCESSORIES**

- A. Drains: Provide threaded pipe connection to allow drainage at all low points and drain connections in stack and breeching systems. Slope piping system to the drain. Pipe size shall be 25 mm (1 inch) minimum.
- B. Instrument Ports: Locate on individual stack or breeching serving each boiler. Locate in non-turbulent zone within 3600 mm (12 feet) of boiler room floor between boiler and economizer (when economizer is provided) or locate accessible from platform. Provide separate ports for the following:
  1. Flue gas oxygen analyzer: Coordinate with analyzer furnished.
  2. Opacity monitor (if required): Coordinate with sensor furnished. Locate downstream from oxygen analyzer.
  3. Stack temperature sensor: Coordinate with sensor furnished.
  4. Draft gauge: 25 mm (1 inch) diameter coupling, plugged.
  5. Test instruments: 25 mm (1 inch) diameter coupling, plugged.
- C. Access Doors: Bolted, gasketed, insulated, with handles. Provide where shown. Minimum opening 400 mm x 400 mm (16 inches x 16 inches).

## **2.4 TYPE B DOUBLE WALL GAS VENTS**

- A. Fabrication: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

# **PART 3 - EXECUTION**

## **3.1 INSTALLATION - PRE-ENGINEERED, PRE-FABRICATED DOUBLE WALL SYSTEM**

- A. Supports: Completely support all systems from the building structure without overloading the building structure or the connected equipment. Support system shall be engineered by the system manufacturer and shall accommodate thermal expansion. Refer to seismic requirements in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- B. Factory-Fabricated Stack or Breeching System:
  1. Install in accordance with manufacturer's printed instructions, NFPA 54 and NFPA 31.

2. Deliver a copy of the instructions to the RE/COTR prior to commencing the installation.
  3. Representative of manufacturer shall provide field training on all installation techniques to all installers.
- C. Connect 25 mm (1 inch) minimum pipes with ball valves to breeching and stack drains. Extend to floor drain.
- D. Boiler or Economizer Outlet Dampers: Locate so that there is no restriction in the flow of flue gas recirculation (if provided).
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

### **3.2 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.3 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 52 35**

**HEAT RECOVERY STEAM GENERATOR (HRSG)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies packaged water tube heat recovery steam generator (HRSG) with trim and accessories, including natural gas duct burner), fuel trains, and emissions control. The heat recovery steam generator specified herein is part of an integrated 'co-generation' or combined heat and power (CHP) system consisting of the Combustion Turbine Generator (CTG), the Heat Recovery steam generator (HRSG), the CHP Plant control system, the natural gas compression system, and the continuous emissions monitoring system. It is the intent of these specifications that the CHP system be furnished complete by a single source of responsibility. Refer to packaging, system integration and single source responsibility requirements stipulated in Section 26 32 14, Combustion Turbine Generator for more specifics.
- B. This specification shall cover all systems and components from the outlet bellows at the combustion turbine generator to the exhaust termination at atmosphere. The complete system shall be integrated with and coordinated with the systems and equipment specified under Section 25 60 00, CONTROL OF CHP SYSTEM, Section 26 57 00, CONTINUOUS EMISSIONS MONITORING SYSTEM, Section 26 52 14, COMBUSTION TURBINE GENERATOR, and Section 23 12 34, FUEL GAS COMPRESSORS.
- C. Throughout Division 23 and other sections, the terms boiler plant, boiler or water-tube boiler are synonymous and defined as the heat recovery steam generator within the cogeneration plant.
- D. Heat Recovery Steam Generator and Associated Components and Systems:
  - 1. Evaporator(s).
  - 2. Economizer.
  - 3. Transition ductwork.
  - 4. Breeching and stack.
  - 5. Duct burner.
  - 6. SCR system.
  - 7. CO catalyst (if required to meet emission levels).
  - 8. Ammonia supply and dilution system.
  - 9. Field instruments and controls.
  - 10. Combustion control system.
  - 11. Furnace viewport construction, locations.
  - 12. Burner management system.

13. Flame scanner blower skid.

- E. The Manufacturer shall design, fabricate, assemble, factory test, deliver and provide startup and commissioning support and training for one (1) Heat Recovery Steam Generator (HRSG) system, complete with all components and design features, as specified herein, for installation at the new Cogeneration Plant at VA Palo Alto, CA. HRSG shall be installed indoors and onto the exhaust of a new gas fired Combustion Turbine Generator (CTG) set. The HRSG shall generate and control the production of steam. The HRSG system shall be the manufacturer's standard and shall be designed in accordance with the latest applicable codes and standards. The HRSG shall be preassembled in modules to the maximum extent possible and ready for immediate site mounting on the foundation and attachment of connections. It is the intention of this specification that the Manufacturer shall be solely and entirely responsible for the design, procurement of materials and components, fabrication and assembly, inspection and testing, preparation of equipment for shipment, delivery and guarantee of the performance of the equipment including subsequent startup, operation and maintenance support. The individual equipment packages of the HRSG system shall be integrated by the Manufacturer to form a completely functional system when connected to utilities, interconnection piping and wiring and appurtenances to form a complete functional and reliable system. The Manufacturer shall, as a minimum, furnish drawings, data and descriptive information for the HRSG system in detail, as specified herein.
- F. The HRSG system shall be complete with all required interconnecting ductwork, exhaust/flue, controls, piping, appurtenances and supports.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 09 91 00, PAINTING.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. Section 23 05 51, NOISE and VIBRATION CONTROL FOR COGENERATION PLANT.
- H. Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS: Valves for boiler trim, non-return stop-check valve, piping for fuel and feedwater trains.
- I. Section 23 50 11, COGENERATION PLANT MECHANICAL EQUIPMENT; feed water pump, condensate receiver/pump, blowdown separator, flash tank economizer and compressed air system associated with cogeneration system.

- J. Section 25 60 00, CHP PLANT CONTROL SYSTEM: Burner controls, combustion control system, boiler water level control, pressure gages, thermometers.

### **1.3 QUALITY ASSURANCE**

- A. Coordinate all new and existing equipment and conditions. This includes, but is not limited to: boiler, boiler trim, burner, fuel trains, gas pressure regulators and available gas pressure, burner control system, combustion control system, economizer, breeching and stacks.
- B. Provide written certification that the entire assembly has been coordinated to achieve the required performance and to provide the required features.
- C. Regardless of fuel input rating, the equipment, installation and operation shall conform to NFPA 85. Where conflicts exist between NFPA 85 and this specification, this specification will govern.
- D. HRSG manufacturer shall provide a minimum of five days job site technical assistance during off-loading, erection, cleaning and commissioning, including all travel and per diem expenses.

### **1.4 WORK INCLUDED**

- A. A HRSG system, consisting of, but not limited to, the following major items:
1. Steam generator complete with evaporator and economizer heating sections, CO catalyst, SCR catalyst, steam and water drum(s), steam separators, drum internals and supports, internal insulation, refractory tube banks and headers, risers and downcomers, tube bank supports, anti-vibration detuning baffles if required, external trim, code feedwater piping assembly to economizer and from economizer to steam drum, etc.
  2. All air and gas ducts, transition sections, bends, expansion joints, duct supports, hangers, internal and external insulation and lining, etc. from the gas turbine exhaust expansion joint (expansion bellows) to the atmospheric termination of the exhaust including all necessary gaskets and hardware.
  3. Low NOx, supplemental firing duct burner at the inlet to the steam generator for supplementary firing with natural gas only, complete with main and pilot gas headers, scanner cooling air header, spark-ignited gas pilots, ignition transformer, scanner air blowers and scanners, burner management and combustion controls, fuel flow transmitters, shut off valves, vent valves and fuel metering valves, etc.
  4. Ammonia injection grid, SCR catalyst section, CO catalyst section and catalyst, ammonia process control unit and control system, and SCR catalyst. Ammonia Injection grid, SCR catalyst, and ammonia control system shall be designed as an integral system to meet the performance guarantees set forth herein.
  5. Duct burner piping rack and burner management system (BMS) control panel assembly supplied for field mounting adjacent to the burner assembly, including instrumentation, controls, protections and safety interlocks, including fuel shut-off and control valves, double

- block and bleed assembly etc. All rack mounted instrumentation shall be factory wired to junction boxes and/or the BMS/ Combustion Control panel as applicable.
6. All valves, relief valves, drains, vents, blowdown, chemical injection connections, sampling, and HRSG accessories in compliance with ASME Section 1 and ASME/ANSI B31.1, Power Piping Codes. All HRSG external piping defined to be within the ASME code sections jurisdictional limits.
  7. Adequate number of access ports and observation doors for HRSG for access and testing at the following locations.
    - a. Upstream and downstream sides of duct burner.
    - b. Upstream and downstream sides of economizer section.
    - c. Upstream and downstream sides of SCR and Ammonia Injection Grid.
    - d. Upstream and downstream sides of evaporator section(s).
  8. All necessary instrument tapping points in the steam, water, air and gas circuits shall be provided. Each sensing point shall have a duplicate test point. All instrument connections shall be provided with a root valve and an instrument isolating valve.
  9. All supporting steel for HRSG system and associated platforms, miscellaneous structural steel, operating platforms, ladders, walkways, handrails, and safety cages shall be provided to allow for safe access for maintenance, repair and observation of HRSG system, meeting all OSHA requirements. All valve operating platforms and ladders. Lifting lugs and lifting frames (if required) for shipping and installation of HRSG components.
  10. All HRSG instrumentation for control and monitoring of the steam generator parameters, including local instruments and control devices and gauges, switches, final control elements, I/P converters, solenoid valves, etc., installed and terminated in a local control panel as applicable.
  11. Gas path test ports between each major airside component.
  12. The major terminal points of the HRSG system shall be as follows:
    - a. Boiler code terminal points shall be set, in accordance with ASME Boiler and Pressure Vessel Code, Section I for multiple steam generators fed from a common feedwater source. Components to be furnished loose for field installation as part of this work include; Main steam non-return valve, steam outlet spool piece, main steam stop valve, feedwater control valve station designed for full range of expected operation (control valve to be removed and replaced with spool piece for shipping), final feedwater isolation and check valves, continuous and intermittent blowdown stop valves, instrument isolation valves within the ASME code piping envelope, etc. Additional boiler external piping (BEP) required shall be shipped loose to site for field installation. Field welding within the BEP code boundaries shall be kept to a minimum.
    - b. Instrument taps shall be provided with isolation valves, additional thermowells for testing and startup purposes shall be provided where required.

- c. Blow down - (Continuous and Intermittent) - From the discharge of the corresponding final blow down valve.
  - d. Fuel Gas - At the inlet to the Burner Fuel Train Skid.
  - e. Drains - Maximum Five feet above grade.
  - f. Turbine Exhaust - Connection to the CTG expansion joint outlet flange.
- 13. Provide all necessary gaskets, bolts, nuts, fasteners and other hardware required to erect and put into operation, the HRSG.
  - 14. HRSG build-out and field cleaning including labor, chemicals and disposal.

#### **1.5 SOUND AND VIBRATION**

- A. All equipment furnished by the Manufacturer in accordance with this specification shall not produce a cumulative sound level in excess of 85 dBA at 5 feet above floor in a free field environment as measured in accordance with ANSI Standards S1.2, "Method for the Physical Measurement of Sound" and S 1.4, "Specification for General Purpose Sound Level Meter".
- B. Any equipment, including accessories, furnished in accordance with this specification will, under normal operating conditions or under operating conditions specified produce either an individual or cumulative sound pressure level in excess of 85 dBA at 3 feet, the Manufacturer shall provide any noise suppression kit or enclosure required to bring noise level into compliance with specification requirements. Exhaust muffler shall provide minimum 15 dBA noise reduction.
- C. ANSI Standard shall apply to:
  - 1. Surface of HRSG.
  - 2. Surface of the expansion joints.
  - 3. Duct burner scanner blower.

#### **1.6 SUBMITTALS**

- A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.
- C. HRSG:
  - 1. Complete catalog information and outline drawing of HRSG and accessories with dimensions.

2. Arrangement and description of construction of pressure parts, casings, drum internals, drum handhole covers and yokes, and support frame.
  3. Drum piping connection sizes, locations, construction.
  4. Technical data including temperature ratings and arrangement of refractory and insulation.
  5. Steam nozzle construction. Capability of steam nozzle and attachment to steam drum to withstand forces and moments imposed by connecting piping. Refer to table of forces and moments on the drawings.
  6. Amount of heating surface, combustion volume.
  7. Weight of boiler and burner assembly, empty and flooded.
  8. Design pressures and temperatures.
  9. Loading diagram of support frame. Evidence that boiler support requirements have been coordinated with foundation design.
  10. Recommended anchorage of boiler support frame to foundation.
  11. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
  12. Predicted surface temperature at front, rear and sides of boiler.
  13. Seismic design data on HRSG and anchorage of HRSG to foundation. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. HRSG Trim: Includes bottom blowoff valves, water column with conductivity probe assembly, water level gage with illuminator, auxiliary low water cutoff, piping, all valves and fittings furnished by HRSG manufacturer, feedwater control valve, safety valves, steam pressure gage, steam pressure switches.
1. Design, construction, arrangement on the boiler.
  2. Pressure and temperature limitations.
  3. ASTM numbers and schedule numbers of piping.
  4. Type and pressure ratings of pipe fittings.
  5. Flow and pressuredrop data on feedwater control valve.
  6. Scale ranges of gages, thermometers, and pressure switches.
  7. Location of water level sensing and indicating devices in relation to normal water line of boiler and highest and lowest permissible water lines of HRSG.
  8. Set pressure and capacity of safety valves.
- E. Duct Burner System:
1. Catalog data and drawings showing construction of complete skid mounted, supplemental firing duct burner system including parts and assembly of complete system.
  2. Drawings, with dimensions, showing burner overall size and mounting on the skid.

3. Drawings and catalog data on all equipment in duct burner system including burner, fuel trains, burner management and combustion controls, fuel supply manifolds, fuel flow transmitters, shut-off valves, vent valves, igniters, burners, and fuel metering valves, and main fuel trains.
  4. ASTM number and schedule numbers on all piping.
  5. Type and pressure ratings of pipe fittings.
  6. Burner flow and pressure data:
    - a. Main burner fuel and flows at maximum required firing rate.
    - b. Igniter (pilot) fuel flow and burner pressure.
    - c. Natural gas main fuel pressure at outlet of burner-mounted pressure regulator.
    - d. Igniter fuel pressures (natural gas) at outlet of burner-mounted pressure regulators.
  7. Full load efficiency and power factor of all motors.
  8. Predicted sound level at maximum firing rate.
  9. Weight of burner assembly.
  10. Drawings showing location and arrangement of drive units and for controlling fuel and air flow.
  11. Weight of burner assembly.
- F. P&ID Diagrams.
- G. Control Schematic Diagrams including control logic, list of safety permissive signals and list of interlocks with Turbine Generator.
- H. Seismic data. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- I. ASME "P" Forms, Manufacturer's Data Report, on boiler and economizer construction.
- J. Pretest Data - Boiler, Burner, Controls: As required by Part 3.
- K. Final Test Report - Boiler, Burner, Controls: As required by Part 3.
- L. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- M. Detailed structural drawings and calculations for all access platforms, railings, seismic anchorage and restraint systems.
- N. Exhaust muffler: Product data including sound reduction value measured in dBA.

**1.7 PROJECT CONDITIONS:**

- A. Fuels to be Fired, Main Duct Burner: Natural gas.
- B. Igniter (Pilot) Fuels: Natural Gas.
- C. Natural Gas: Heating value shall be assumed to be per PG & E Rule 2. Pressure provided to the inlet of the boiler-mounted regulators will be \_\_approximately 172\_\_kPa (\_\_25\_\_psi) as maintained by the main gas regulator station.

**1.8 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. ASTM International (ASTM):
  - 1. A182/A182M-11a Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and parts for High Temperature Service
  - 2. A193/A193M-12 Standard Specification for Alloy Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
  - 3. A194/A194M-12a Standard Specification for Carbon Alloy and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
  - 4. A312/A312M-11 Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
  - 5. E84-04 Standard Test Method for Surface Burning Characteristics of Building Materials
- C. American Society of Mechanical Engineers (ASME):
  - 1. Boiler and Pressure Vessel Code - 2007 Edition with Amendments.
    - a. Section I Power Boilers
    - b. Section II Material
    - c. Section VII Recommended Rules for Care of Power Boilers
    - d. Section IX Welding and Brazing Qualifications
  - 2. Performance Test Code (PTC):
    - a. PTC 4-2008 Fired Steam Generators
  - 3. Code for Pressure Piping:
    - a. B31.1-2007 Power Piping
- D. Factory Mutual Engineering Corporation (FM)
  - 1. 2010 Approval Guide
- E. National Fire Protection Association (NFPA):
  - 1. 70-2008 National Electric Code



2. 85-2007 Boiler and Combustion Systems Hazards Code

F. National Board of Boiler and Pressure Vessel Inspectors (NBPVI):

1. NB-23-2007 National Board Inspection Code

G. Department of Health and Human Services, Food and Drug Administration (FDA):

1. CFR 21, 173.310, Boiler Water Additives Permitted in Plants Where Steam Contacts Food

H. Underwriters Laboratories (UL):

1. UL 795, Commercial - Industrial Gas Heating Equipment

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

A. Performance Conditions:

1. The following site conditions are utilized to develop output and emissions guarantees:

- |   |                   |
|---|-------------------|
| a. Location.                                | Palo Alto, CA     |
| b. Altitude.                                | 50 Ft. ASL        |
| c. ASHRAE 1% wet bulb.                      | 69Deg F           |
| d. ASHRAE 1% cooling dry bulb.              | 93 Deg F          |
| e. Combustion air temperature.              | 93 Deg F          |
| f. Natural gas LHV.                         | Per PG & E Rule 2 |
| quality(expected value 1020 +/- 20 btu/scf) |                   |
| g. Turbine operating range.                 | 95% - 100% load   |

B. Steaming Rate and Quality:

1. The Manufacturer shall guarantee that steam after the evaporator outlet will be 99.97% dry when the total solids concentration of the feedwater is maintained in accordance with ABMA recommended standards. Solids carry-over shall not exceed 1 PPM under all conditions, including start up and shut down.
2. Steaming rates shall be based upon the following parameters:
  - a. Steam pressure of 100 psig dry and saturated at the outlet of the steam non-return valve.
  - b. Feedwater temperature of 217 Deg. F. at the inlet to the economizer (feedwater comes from existing Plant, B/40).
  - c. Maximum blowdown rate of 2.2% (fired); 2.1% (unfired).
  - d. 100% load turbine exhaust gas (TEG) flow of 63,405 lbm/hr. @ 59 Deg. Ambient (unfired); 1558 Deg. F (fired).
  - e. 100% load turbine exhaust gas (TEG) temperature of 980 Deg. F.
  - f. Maximum stack temperature at 100% turbine loading of 280 Deg. F (unfired); 286 Deg. F (fired).

3. Based upon the conditions listed above, the Manufacturer shall guarantee the following minimum steam production rates:

- a. Unfired steam production. 12,000 minimum lb/hr
- b. Fully fired steam production. 18,000 minimum lb/hr

C. Duct Burner and Gas Side Performance:

- 1. The Duct burner shall provide stable operation for all operating points from 10% to 100% maximum continuous rating (MCR) coincident with turbine generator operation from 50% to 100% with no deleterious impingement on the HRSG system.
- 2. The following parameters shall be guaranteed by the Manufacturer:
  - a. Maximum gas side pressure drop of 10" w.c. from the inlet transition duct to the stack outlet. Manufacturer shall provide detailed draft loss breakdown by component.
  - b. Minimum duct burner turndown of 10 to 1.
  - c. Maximum duct burner heat input of 10.5 MMBtu/hr based on LHV.
  - d. Maximum Duct Burner NOx contribution of 0.06 lb/MMBtu from 50% to 100% MCR. Although the NOx contribution levels given in lb/MMBTU (HHV) can be higher at burner loads below 50%, at no point can the duct burner emissions at less than 50% MCR exceed the mass flow rates (lb/hr) produced at the 50% maximum continuous rating (MCR) operating point.

D. Emissions Performance:

- 1. The Manufacturer shall provide for the adequate removal of combustion emission byproducts from the combustion turbine and the duct burner in order to guarantee the following stack emission requirements set forth by the local air permitting district with the turbine firing on natural gas:
  - a. NOx emissions: 2.5 ppmdv corrected to 15% O2
  - b. CO emissions: 5.0 ppmdv corrected to 15% O2
  - c. Ammonia slip: 5.0 ppmdv corrected to 15% O2
- 2. The above required stack emissions are based upon the following Turbine Exhaust Gas (TEG) emissions guarantees from 95% to 100% of turbine generator loading :
  - a. NOx emissions: 15 ppmdv corrected to 15% O2
  - b. CO emissions: 50 ppmdv corrected to 15% O2

**2.2 GENERAL DESIGN:**

- A. Detail design of the entire HRSG system shall be the responsibility of the Manufacturer. The Manufacturer shall custom-design the HRSG. The string arrangement of gas turbine exhaust duct, duct burner, evaporator sections, CO Catalyst, Ammonia Injection Grid, SCR Catalyst and economizer shall be optimized to achieve the desired performance while meeting any dimensional requirements shown on the drawings.
- B. The difference of the temperature of the boiler exit gas from the saturation temperature of steam in the evaporation zone (which is defined as pinch point) shall be carefully chosen to result in an optimum design of the

overall HRSG. The Manufacturer shall provide details of calculations of the pinch points, in both fired and unfired mode of operation. Similarly, the difference of evaporator saturation temperature and temperature of feed water inlet to the evaporative drum (which is defined as economizer approach) shall be optimized.

- C. The steam generator and all pressure vessel components shall be designed, fabricated, examined, inspected, and tested in accordance with Section I, Division 1 - Pressure Vessels, Section II - Material Specifications, and Section IX - Welding and Brazing Qualifications of the ASME Boiler and Pressure Vessel Code.
- D. The HRSG shall be inspected during construction in accordance with the requirements of ASME Boiler Code, and after completion shall be stamped with all identifying markings and symbols as required by the latest edition of the ASME Boiler Construction Code, including but not limited to, National Board (NB) registration and "S" stamp as required by the ASME Code. Stamping shall include National Board number with shop inspection by National Board Inspector.
- E. The HRSG system, including all applicable piping systems, shall be designed in accordance with ASME Boiler Code Section I and as follows:
  - 1. All drum and other connections required for proper operation shall be provided.
  - 2. ANSI 300 lb. and 150 lb. rated system connections shall be flanged, except for connection sizes 2" and smaller shall be either threaded or socket weld union-end, as required by applicable codes.
  - 3. The weight of each HRSG system shall be uniformly distributed to the maximum extent possible. The boiler section base shall be constructed of welded structural shapes of standard construction.
- F. HRSG will be connected to a gas turbine unit to harness the sensible heat contained in the exhaust. In addition, supplemental fuel (natural gas only) will be fired in the duct burner to produce additional steam.
- G. HRSG will be located indoors.
- H. Casing, piping, steam drums and other components shall be insulated and lagged for heat retention. All insulation coverings shall have a fire rating in accordance with ASTM E84 of 25 or less. Casing shall be constructed of 1/4 inch carbon steel outer casing internally insulated and lined with 14 gauge steel liner. Refer to Section 23 07 11, HVAC and COGENERATION PLANT INSULATION, for insulation types.
- I. Each HRSG will have only evaporator and economizer sections. There will be no superheaters.
- J. The Evaporator(s) shall be of the watertube type, working on the principle of natural circulation. Assisted or forced circulation designs will not be permitted.

- K. HRSG design shall permit easy access inside. Good maintenance aisles will be provided to gain access to the heat transfer tubes, so that tube elements may be removed, repaired or plugged.
- L. The gas turbine is expected to run fully loaded on a continuous basis.
- M. For better quality control, emphasis shall be given on maximization of shop assembled modular construction, with all welded features for pressure parts, tube banks, tube supports, stub connections into the drum, etc. Site fabrication work shall be minimized. Each portion of the HRSG system shall be provided with appropriate lifting eyes, hooks, frames, etc to promote the safe and efficient unloading and setting of the equipment. The design emphasis of the HRSG should be on high reliability and simplicity.
- N. HRSG shall be designed to provide ample evaporating tube surface for the maximum capacities specified and a sufficient number and size downcomers to assure proper circulation in all parts of the boiler, even under rapid start-up conditions.
- O. All equipment, ductwork, etc. provided by the Manufacturer shall be so designed to ensure that a average casing surface temperature of 140°F, considering a still surrounding air temperature of 100°F. However, it is recognized that certain areas will exceed this temperature limit due to the nature of the HRSG system design. These areas, as defined by the Manufacturer, are: ducting/boiler flanges, observation/test ports or anywhere that the duct/casing insulation is penetrated by anchors or stiffeners at the duct/casing attachment area. Provide protective insulation where required to protect personnel who could come in contact with hot surfaces.
- P. In accordance with the requirements of the ASME Boiler Code, HRSG shall be supplied complete with all valves and features required for a steam generating system consisting of multiple steam generators attached to a common feedwater supply and steam collection header. It is the intent of this specification that the HRSG be provided complete with all trim required, and that field assembly be kept to a minimum. All instruments, level columns, bridles, etc shall be provided with isolation valves in the piping connections so that the item, including any valve which may be integral with the item can be removed while the unit is operational. At a minimum, the following items of trim are to be provided.
  - 1. Double-valved mud drum (continuous) blowdown piping.
  - 2. Double-valved surface I (intermittent) blowdown piping.
  - 3. Drum internals for removing entrained water from steam.
  - 4. Water column for low-low, low, high and high-high level probes alarms with isolation valves and drain valves.
  - 5. Sightglass with drain valve.
  - 6. Mirrors (or equivalent system) so that sightglass can be clearly seen from grade level within reach of the blowdown valves.
  - 7. Drum pressure gauge.
  - 8. Chemical feed connections, isolation valves, and check valve.

9. Auxiliary low-low water cutout (LWCO) level float switch with drain.
10. Continuous blowdown with stop valve and automatic control valve.
11. Main steam non-return valve and Main steam stop valve.
12. Main steam spool with drain valves.
13. Safety relief valves for drum.
14. Safety relief valve(s) for economizer.
15. Isolation valves for drum level transmitter.
16. Complete feedwater control station including feedwater control valve with actuator and positioner, isolation valves, bypass gate valve and drain valves.
17. Feedwater stop valve and check valve.
18. Feedwater piping between control valve and economizer.
19. Economizer Isolation valves and bypass valve.
20. Economizer drain valve
21. Economizer inlet and outlet temperature (water side) indicators and connections for transmitters.
22. Economizer inlet and outlet temperature (gas side) indicators and connections for transmitters.
23. Connections for sample coolers (coolers by others).
24. Pressure point taps for the gas side of the HRSG for the following locations.
  - a. Upstream of duct burner.
  - b. Downstream of duct burner.
  - c. Between evaporator sections (if applicable).
  - d. Between evaporator sections and economizer.
  - e. Upstream and downstream of the SCR catalyst.
  - f. Upstream and downstream of the SCR catalyst.
  - g. Downstream of the economizer.

Q. Materials:

1. The Manufacturer shall indicate on his approval prints, what ASME specification grade number he will be furnishing for materials specified. Material shall be Manufacturer's standard for the application or as specified herein.
2. Nozzle, nozzle reinforcement plates and fittings shall be constructed of the same materials as the component which they are attached to.
3. No asbestos or asbestos bearing materials are permitted.

## 2.3 DETAIL DESIGN

- A. Each heat recovery steam generator (HRSG) shall generate the scheduled lbs/hr of dry saturated steam at 150 psig when operating in the unfired mode with the gas turbine operating at its full base load. In order to

ensure efficient recovery of exhaust heat of the gas turbine, the pinch point differential shall not be less than 20 Deg. F. under this design condition.

- B. The HRSG design shall be developed on the basis of natural circulation only, i.e., it shall not rely on circulation pumps either in part (assisted circulation) or completely (forced circulation) to promote fluid flow through the hot tube path.
- C. The temperature of the exhaust gases leaving the HRSG shall be at least 20 Deg. F. above the dew points for all entrained condensable gases, under all operating conditions in the ranges defined as:
  - 1. Minimum load and full load on gas turbine.
  - 2. No firing and full firing in duct burner.
  - 3. Extremes of ambient air temperature from 0°F to 100°F.
- D. Evaporator:
  - 1. Each evaporator section of the HRSG shall be complete with a steam drum at the top and a mud drum (or a large size header) at the bottom.
  - 2. The evaporator may be split into two subsections as seen appropriate to provide for an optimum operating temperature for the CO and SCR catalysts.
- E. Drums:
  - 1. The steam drum is to provide satisfactory steam/water separation, steam drying and maintenance of outlet steam quality within the specified limits under all operating conditions.
  - 2. Drum and headers shall be located away from the hot exhaust gas. Drum shall be constructed of steel plates as per applicable codes of ASME with material properly selected for operation conditions.
  - 3. Manufacturer shall provide an elliptical manhole in each head of each drum with a forged steel bolted manhole cover plate and forged steel yokes, with suitable gasket for each manhole opening. Manufacturer shall also provide insulation curbs for each manhole. The minimum size of the manhole clear opening for the steam and lower mud drum shall be 12" x 16".
  - 4. Manufacturer shall furnish and install suitable internals for feedwater, chemical feed and continuous blowdown distribution in the steam drum. Furnish and install suitable dry pipe or separating device in the steam drum under the main steam outlet to separate entrained moisture from the steam to assure delivery of steam with a dry moisture content of 99.97% when boiler concentrations are maintained in accordance with ABMA recommendations. The drum internals along with steam separating device shall direct the flow of steam and water so as to obtain an optimum distribution of drum metal temperature over the entire operating range. Also, the internals and the separator used shall be of low loss type. The arrangement and fabrication of the drum internals shall permit easy removal and replacement through drum manholes. The feed water pipe(s) from the economizer entering the drum shall be spaced suitably so that there is no uneven

distribution of flow over the entire length of the drum. Chemical feed and continuous blowdown connections shall be located on opposite ends of the drum.

5. The drum shall be sized to hold a minimum of 2 minutes storage (at MCR) of water inventory between the normal water level and the low-low water trip level. From the normal water level to empty, the drum shall be sized to hold a minimum of 5 minutes storage (at MCR) of water inventory. The calculation of holding capability shall include the effects of sizing the drum intervals and no quenching action of incoming feed water, assuming that the supply of the same has been completely cut off. The steam drum shall have adequate freeboard space to accommodate the swelling of water during start up, without flooding drum internals. At start up or during loss of steam load, no carryover of water droplets, along with generated steam, is permitted. Water surge volume in steam drum shall be adequate to accommodate the swelling or shrinkage, resulting from a change in steam load of 20% of HRSG maximum continuous rating (MCR) in one (1) minute, without any water carryover or actuating high/low level alarms, or trips.
6. An adequate number of level and pressure instruments shall be provided. Two sets of tapping points with seal pots, valves, etc. at each end of the drum shall be provided for remote level measurement and control purposes in addition of the tapping points for one local level gauge glass. Provision shall also be made with T-off or by independent tappings for level column and level switches for alarm and HRSG trip on drum level LWCO, Low-Low, Low, High and High-High. Independent tappings for remote drum pressure control and measurement shall be provided on the steam piping. All nozzles shall be welded to the drum and headers and shall extend through the insulation where applicable. The drum shall have sufficient number of nozzles for drum auxiliaries, drain, vent, blowdown, air release, feedwater, chemical feed, steam safety valves, instruments, sampling connections, etc. as necessary.

F. Tubes:

1. The tubes shall be not less than 2" in diameter for the evaporators and 1-1/2 inches in diameter for the economizer, and the thickness shall conform to the ASME Code for the pressure specified. The tubes shall be made from electric resistance welded carbon steel. Fouling factors shall be 0.001 for outside fins and 0.001 for inside fins. Fin density shall be not greater than 6 per inch. Fins shall be attached to the tubes by a high frequency continuous welding method. Fin material shall be 409 SS for the leading evaporator and carbon steel for the secondary evaporator and economizer.
2. The tubes shall be bent to a true radius. Tubes that are distorted in bending, flattened or ridged will not be accepted. Tube holes in the drums shall be drilled, reamed and serrated. The design of the tubes shall permit both drums and all tubes to drain by gravity.

G. HRSG Enclosure, Insulation and Cladding:

1. The entire boiler shall be constructed to form a complete gas tight construction without any leakage of exhaust gas from within the setting under any condition of operation.

2. The design and construction of enclosure shall prevent distortion of steel work due to thermal expansion and deterioration of insulation. The wall construction shall be designed without permanent deformation. The pressure withstanding capability of the enclosure including interconnecting ductwork shall not be less than (+) 20 inch of water column at 67% of yield strength. The Manufacturer shall also check and confirm the design of the HRSG enclosure against any internal vacuum if created during sudden flame out. The primary objective of enclosure design shall be to achieve reliability and long life.
3. Observation ports, doors and all other openings shall be provided with sealing and cooling air to prevent hot gases from blowing out when these items are opened or operated. All inspection doors and access manholes shall be of the quick opening type and provided with safety features to prevent opening of the doors without seal air pressure when the boiler is in operation. Sealing and cooling air shall be supplied from the LP blower system provided by the Manufacturer.
4. The HRSG pressure casing, steam drum, water/mud drum and all interconnecting ductwork between the gas turbine exhaust and economizer outlet transition, subject to hot exhaust gases shall be complete with a thermal insulation. The setting and insulation shall be so designed to ensure that an average casing surface temperature of 140°F, considering a still surrounding air temperature of 100°F, is not exceeded under any load conditions. The Manufacturer shall guarantee the design against overheating, warping or burning of the casing.
5. The boiler design shall utilize non-waterwall convective evaporator sections. Evaporator sections shall be constructed with internal mineral fiber insulation and lagging. Drum head will not be factory insulated. The remaining exposed parts of the steam and mud drums shall be insulated with mineral wool, and covered with 12 gauge embossed, corrugated aluminum jacketing. Steam drum shall be covered with 7 gauge lagging.
6. Boiler outer casing will be 1/4 inch thick carbon steel. For all temperature measurement within the boiler casing, the Manufacturer shall furnish temperature elements in respect of local as well as remote measurement. All necessary access, observation, and cleaning doors with frames for building into the casing shall be provided. The doors shall be insulated and be perfectly gas tight under all working conditions. The design and construction of the doors shall be rugged and shall ensure freedom from distortion.
7. At low locations of enclosures, drain pockets shall be provided to collect liquids. The drain pockets will be provided with normally closed valves.
8. Provide casing with capped washout drain fittings.

H. Ducts and Expansion Joints:

1. The complete ducting system, including the expansion joints, from turbine transition duct and bellows to the economizer outlet transition, and on through the roof to the final discharge shall be provided as part of this section and designed for an internal pressure and vacuum as required.



2. The ducting system leading into the duct burner and to the inlet of HRSG should be designed with a slow angle of divergence to reduce formation of eddies and turbulence. To improve the flow distribution, turning vanes or similar devices for correction of flow patterns may be employed.
3. Material of duct work, guide vanes, expansion joints and all other components of the system should be as follows:

Operating temperature not exceeding Deg. F listed below:

Carbon Steel	up to 800
Corten Steel	up to 900
Stainless Steel 309	up to 1200
Stainless Steel 304/316	up to 1600
Stainless Steel 310	up to 1700

- a. The thickness of duct wall shall be 1/4" minimum, and shall be of welded construction, properly reinforced. Continuous welding at joints shall ensure gas tightness. Flanged joints shall be provided at all field connections and terminations with other Manufacturers. Flanged connections to be field welded by others.
  - b. All material and construction shall be suitable for thermal cycling and continuous operation at the design temperature. Stress levels will be maintained at limits to ensure a minimum creep life of 100,000 hours at the design temperature.
4. All hot ducts shall be insulated and shall be provided with necessary ribs or attachments for proper fastening of insulation. The exposed surfaces of the ducts and other equipment shall be insulated or covered to limit the external surface temperature to a average of 140 Deg. F at 100 Deg. F. still ambient air condition and also to prevent the formation of condensed moisture or "sweat". Hot ducts shall be insulated with material suitable up to the operating temperature plus 20 Deg. F margin. Insulation at equipment openings and flanged joints shall be finished off with metal edges to allow removal of cover and joint bolts so that the equipment can be opened for access of servicing without damage to the insulation.
5. Suitable supports and anchors, expansion joints, access doors, adjustable spring hangers, flue gas sampling connections, gaskets, thermal insulation fasteners, etc. shall be furnished as required. Ductwork shall be reinforced with structures to eliminate any vibration or pulsation induced from flow dynamics. Provide guy supports on elevated stacks.
6. Low points of ductwork will be provided with drain pockets, suitably blanked off.
7. Expansion Joints:
  - a. Expansion joints shall be provided to absorb longitudinal expansion or contraction and shear movements due to temperature differential or misalignment and thus relieve stress levels from major equipment. Expansion joints shall be of reinforced heat resistant fabrics with internal stainless steel liner or all-metallic, suitable for the working environment, and shall be

of bellows design to maintain leak tightness. Sliding or sleeve type expansion joints are not acceptable.

- b. Welds on expansion joints shall be dye penetrant tested, after forming and welding.
- c. The internal dimensions of the expansion joint shall match that of the main duct or boiler enclosure. The joints shall be covered with the internal plates to prevent eddies and turbulence. The expansion joints shall be lagged and clad separately from the main section of the duct.

I. Vents, Drains and Blowdown:

- 1. The HRSG shall be provided with all necessary vents, drains and blowdown systems required for the safe operation and maintenance of the HRSG plant.
- 2. Air vents shall be incorporated in HRSG steam and water circuits, and also on drum. All air vent lines shall be complete with separate isolation valves. Double isolation valves shall be provided if required to meet ASME pressure vessel code requirements for boiler external piping at the customer interface.
- 3. All piping and fittings associated with the water and steam circuits of HRSG shall be completely drainable.
- 4. Both continuous (CBD) and intermittent (IBD) blowdown piping and isolation valves shall be provided. CBD will be done as surface blow from top steam drum and the circuit shall be sized for a maximum rate of 3 percent of fired steaming capacity. IBD will be done from bottom water drum/headers to clear dirt, rust etc. which may be accumulated in boiler circulation circuit.
- 5. To provide for functional checks on the drum water level gauge, a blowdown arrangement shall be provided and terminated through the isolation valves.

J. Steel Work:

- 1. The Manufacturer shall supply all necessary structural steelwork for encasement support, bracing of the HRSG and its ancillary equipment and access rails, ladders, platforms and the like, to all maintainable or monitored sections including outdoor flue stack emissions and monitoring system.
- 2. The steelwork shall be provided in accordance with the general requirements for steelwork meeting relevant AISC specifications.
- 3. Steelwork shall be provided for Manufacturer provided piping and instrumentation mounting.
- 4. Structural steel shall be supplied in pre-fabricated form to minimize site erection work.
- 5. The design of the steel structures associated with the HRSG shall meet the following requirements:
  - a. The supporting structure shall be designed considering the internal forces and expansions.

- b. Consideration shall be made that the steel structure can also accept forces of the pipes and ducts that will be eventually attached to the HRSG system.
- c. In addition to this, the steel structure must be able to resist the forces resulting from water filling of the boiler and pipes during hydraulic test, or from other loads during erection.
- d. Special care shall be given to the design of pipe racks or supports, as applicable, for steam and feedwater pipes, which must be able to also support these pipes during water filling (hydraulic test or acid cleaning).
- e. Ladders and platforms shall be supported so that no forces shall be introduced into the boiler body itself unless provided for by design.
- f. All nuts, bolts and washers must be galvanized or cadmium-coated, and properly protected against corrosion before installation.
- g. Other than the anchor bolts, Manufacturer shall supply all necessary foundation embedments, leveling plates, anchors, etc.
- h. Manufacturer to implement local seismic design conditions per CBC 2006.

K. Platforms and Ladders:

- 1. A complete system of ladders and platforms and shall be provided as required for proper operation and maintenance. The design shall meet requirements of OSHA standards. All platforms, walkways and stairways shall have a minimum clear width of 3 feet and be designed for a minimum load of 100 pounds/sq.ft.
- 2. A complete system of ladders and platforms and shall be provided as required for proper operation and maintenance. The design shall meet requirements of OSHA standards. All platforms, walkways and stairways shall have a minimum clear width of 3 feet and be designed for a minimum load of 100 pounds/sq.ft.
  - a. All operating valves.
  - b. Instruments.
  - c. Observation doors/ports/manways.
  - d. Steam drum manholes, water gauge glass and columns.
  - e. Safety relief valves.
- 3. Platform perimeters and major openings shall be protected with hand railings, constructed with tubular fittings and pipes. A minimum of 7 feet - 0 inches headroom shall be maintained for all walkways and platforms. Continuous kick plates, projecting above the platform elevation shall be provided around all openings and platform edges.
- 4. Vertical ladders shall be provided with a safety cage as required by OSHA. Bottom of ladders shall be prepared for proper anchorage, either to additional platforms or floor slab.
- 5. Provision shall be made in the HRSG casing and access platforms for the rapid and convenient installation of the inspection scaffolding furnished for maintenance and inspection.
- 6. All platforms and ladders shall be painted.

- L. Pipe Sleeves, Instrument Connections and Test Ports:
1. Provide pipe sleeves in the walls of the boiler for combustion control, sampling and instrument connections.
  2. Provide instrument connections in casing and flue outlet as required. All connections shall be properly sized, located and capped.
  3. Provide test ports in the following locations: Upstream of duct burner, downstream of duct burner (before evaporator), between evaporator sections, upstream and downstream of ammonia injection grid and SCR catalyst and between the last evaporator section and economizer. To the extent possible locate such ports in areas of clear unobstructed flow as far as possible from upstream and downstream obstructions.
  4. At every test port provide a pad eye or hook welded to equipment/duct, rated for 300 pound load. Locate this support approximately 20 inches above the test port (or highest test port in a row of test ports).
- M. The Manufacturer shall furnish all miscellaneous steel, hangers, shoes, attachments, base plates and related items for hanging or supporting of their equipment, piping and accessories.

#### **2.4 HRSG TRIM AND ACCESSORIES:**

- A. The boiler trim shall include a self-contained water column with all necessary alarms, cut-offs, gauges, isolation valves, drains, vents, instrument taps, etc. The water column and its level must be clearly visible from the floor level next to the boiler feedwater control valve station. If the sight line to the sight glass is obstructed, a lighted mirror assembly shall be provided.
- B. All necessary continuous and intermittent blowdown, chemical feed, vent and drain connections shall be provided with isolation valves. Automatic Valve and Flow control of continuous blowdown shall be by others. Additional isolation valves shall be provided as per ASME B31.1 so that the customer interface, for all ancillary taps lies outside of the domain of Boiler External Piping.
- C. A minimum of two safety relief valves shall be provided and sized in accordance with the ASME code.
- D. Chemical feed connection with isolation valves shall be included.
- E. All main steam and feedwater components within the jurisdiction of ASME Code Section I, shall be code stamped. For the main steam section, the stop/check (non-return) valve shall be of angle type and the second stop valve shall be of straight-through type. Piping between these two valves shall be supplied and fitted with a visible and accessible drain valve.
- F. A feedwater piping system shall be designed and supplied by the Manufacturer. It shall be complete with a feedwater level control valve, a three valve bypass assembly, and feedwater stop and check valves shall be provided in a pre-fabricated piped assembly. The piping design shall

be stress analyzed and provided with hangers, supports, hardware, etc. by the Manufacturer to allow for field installation (if so required) by others.

- G. The economizer trim shall be provided with means for isolation, including manual bypass, vent, drain and safety valves. If the economizer or its tubes are removable, specify location and dimensions of space required for its removal.
- H. The Manufacturer shall provide a complete list, including number, size, manufacturer and model number of the steam, feedwater, and economizer trim with his proposal. Trim shall be factory-mounted with all integral connecting piping and drain lines terminating with a valve 3 feet above the operating floor level.

## **2.5 ECONOMIZER:**

- A. The Manufacturer shall furnish an economizer arrangement for the HRSG complete with structural steel support, interconnecting single case duct from last evaporator section gas outlet to economizer gas inlet, and interconnecting feedwater piping from economizer feedwater outlet to boiler feedwater inlet. Economizer shall be designed for inlet flue gas temperature, and outlet flue gas and feedwater temperatures establish by the Manufacturer for optimal HRSG system performance based on an inlet feedwater temperature of 217 degrees F. Economizer shall be double cased and externally insulated.
- B. The unit shall incorporate lifting lugs to facilitate loading and unloading.
- C. The economizer internal casing shall be 10 ga. carbon steel seal welded, gas tight, and externally insulated, secured and externally lagged with 0.016" thick corrugated aluminum lagging.
- D. The gas side connections on the economizer shall be plate flange type with drilling for bolt holes for aligning to adjacent components. The water side connections shall be flanged.
- E. Fin tubes shall have maximum density of 6 fins per inch.
- F. The design, fabrication and construction of the economizer shall be in accordance with ASME Code Section I.
- G. The economizer shall be a non-steaming type.

## **2.6 LOW NO<sub>x</sub> DUCT BURNER:**

- A. The duct burner must be capable of operating safely and continuously between 10 percent and 100 percent of its design heat output, as a minimum.
- B. The duct burner system shall be pre-wired and assembled and tested at shop before shipment to project site to minimize field installation time. All piping trains, such as main and pilot gas, shall be mounted on a free-standing piping rack pre-wired to the flame safety system control cabinet/panel and/or a junction. The piping trains shall be provided in

- accordance with the requirements of NFPA, FM (approved components) and ASME/ANSI codes, as applicable. Internal piping and wiring shall be pre-assembled. External piping and wiring shall be by others. All duct Burner Management System controls and accessories shall be located on a self-contained, free standing, skid mounted on the gas piping rack to provide HRSG system status/monitoring and emergency stop.
- C. Electrical enclosures shall be NEMA-12 minimum. Entire system design shall comply with requirements of NFPA and FM standards.
- D. Gas line connections shall be flanged for connections 2-1/2 inches and larger. Connection sizes 2 inches and smaller shall be either threaded or socket weld union-end, as required by applicable codes. The gas piping rack shall be provided with a single inlet connection to feed both main and pilot gas lines. Valves shall be cast iron construction, as applicable.
- E. The frame of the duct burner shall be constructed of structural steel of 1/4 inch minimum thickness, primed with 3-4 mils of inorganic zinc primer and finish coat. The frame assembly will be provided with matching flanges for attachment to transition ductwork with the HRSG/gas turbine. Seal welding or bolting can be used to do field joining.
- F. The frame shall be internally insulated with 8 lb/cu. ft ceramic fiber blanket and lined with 316 SS. All thermal insulation or refractory material shall allow for thermal expansion or contraction, without cracking, detachment or any other injurious effects.
- G. Burner Elements:
1. Burner elements coming in contact with the flame shall be constructed of stainless steel.
  2. Burner elements shall be secured to the burner frame to eliminate any vibration induced from fluid flow. The elements shall allow for thermal growth and contraction with variation of load.
  3. When multiple burner elements are used, distribution headers with isolation valves, pressure gauges, etc., shall be provided separately for fuel gas, and scanner cooling/purge air.
- H. Igniter Pilot:
1. For ignition of natural gas, the Manufacturer shall provide high energy spark-ignited gas pilots of the interruptible type.
  2. If the pilot gas type igniter being provided is air-cooled, the igniter heads shall be made of stainless steel 304 or better. Pilots should be shielded from turbine exhaust gas flow to assure a stable flame, avoiding blow out of pilot flame. One pilot and ignition transformer shall be provided, as a minimum, for each burner element. - The burner pilot will be cast iron. Pilot firing tube to be constructed of 316SS.
- I. Flame Scanners and Flame Safety System:
1. A minimum of one flame scanner and amplifier shall be provided for each burner element or runner. The flame scanners shall be of

ultraviolet (UV) type or infrared (IR) type, or a combination of the two.

2. Each flame scanner shall be located on a fixed base.
3. The flame scanners shall be cooled and purged continuously to keep them clean of any particulate matter from combustion of fuel. If air is used as coolant, as well as purging agent, the same shall be supplied by the low pressure blower system.
4. The flame safety system shall be enclosed in a free standing NEMA-12 enclosure.

J. LP Blower System:

1. The Manufacturer shall provide a duplex LP (low pressure) blower system to supply air to the scanner, igniter and observation ports for the HRSG system as required by the Manufacturer. The system shall be complete with all necessary controls, instrumentation, inlet filters, silencers, interconnecting piping and valves (i.e. isolation and check), common outlet flexible connection, etc.
2. This system shall be skid-mounted and shall be integrated by the Manufacturer to form a completely functional system such that the Contractor need only connect utilities, interconnection piping and wiring and appurtenances to form a complete functional and reliable system. The Manufacturer supplied system controls shall be designed to allow either manual or automatic start of a different blower as needed to provide continuous air supply to maintain HRSG system operation.

**2.7 AMMONIA SUPPLY, DILUTION, AND CONTROL SYSTEMS:**

- A. The intended supply source for ammonia to the SCR system is from bottle anhydrous ammonia. The work of this section shall include ammonia gas storage, including cabinet, ammonia bottles, manifolds, all valves and appurtenances plus piping between cabinet and ammonia process (flow) control unit.
- B. The supply of Ammonia Vapor to the Ammonia injection grid shall be controlled by a vaporization (as applicable), dilution and control skid. The Ammonia injection grid, SCR catalyst, and Ammonia dosing and control skid shall be designed and packaged by the HRSG Manufacturer to function as a seamless system. The control system shall receive a feedback signal from a NOx analyzer and utilize fuel flow signals provided from the HRSG Combustion Control system and the Turbine control system to determine the instantaneous flow rate of diluted ammonia vapor to provide to the injection grid.
- C. Control logic for the Ammonia dilution and control system shall be accomplished using a Programmable Logic Controller (PLC). Configuration of this PLC can be either as a dedicated SCR control PLC or can be accomplished as an integral part of the PLC based Combustion Control system.

- D. The following specific requirements shall apply and the following shall be provided:
1. The anhydrous ammonia process control unit shall consist of Stainless Steel skid package with two redundant Dilution Air Blowers, Motor Starters, ammonia control piping & Instrument air piping, all skid mounted hardware, instrumentation and wiring. The process control unit shall have a minimum Metering and Dilution Capacity of 9 lbs/hr delivered at 32" W.C.
  2. The ammonia gas delivery and storage system shall be housed safely and in accordance with code and provided with a gas monitoring system. The manifold system shall be contained in a fire rated Class 1 Division 1 enclosure and provided with any heating required to ensure an adequate supply of ammonia during cold months. The enclosure shall provide for a means of containing and exhausting any leaks that may occur from the cylinders via an explosion-proof fan and external ductwork that will operate if the gas monitor detects a leak. The gas monitor shall annunciate a local alarm beacon and horn and also tie into the cogen SCADA system within the building and additionally alarm through the FMCS DDC system. The manifold shall also have an emergency shutoff valve located just before the regulator on the control panel and controlled by a break box and via operator from the SCADA system and the gas detector.
  3. Provide the required number of cylinders to ensure an adequate supply and turn over for the local ammonia supplier so there is never any chance to run out, yet not exceed the code limit for storage within the room. A scale shall be provided to allow the users to determine the remaining product. Provide a nitrogen cross purge system to allow for the easy and safe change-out of cylinders. Provide the appropriate personal protective equipment required for start-up and cylinder changes for at least two personnel.
- E. Ammonia piping shall be ASTM A312, TP304/304L stainless steel, Schedule 40 with 3000 lb forged stainless steel fittings. ASTM A182-F304/304L, socket weld ends and 150 lb RF stainless steel flanges, ASTM A182-F304/304L, per B16.5, socket weld ends where mating to flanged equipment.
1. Flange bolts shall be ASTM A-193, B7 stud with 2, heavy hex nuts, ASTM A-194, Gr. 2H.
  2. Gaskets shall be spiral-wound, 304 SS/PTFE with stainless steel inner ring.
  3. Needle valves shall be 316SS body, stem and tip, FNPT connectors, hard seat, 6980 psig rated at 100 deg F.
- F. Nitrogen purge piping shall be ASTM A312, TP 316 stainless steel, or as otherwise recommended by manufacturer for application. Schedule 40, with 3000 lb. forged stainless steel fittings. Other components similar to ammonia piping section above.

## **2.8 AMMONIA INJECTION GRID AND SCR CATALYST:**

- A. The Ammonia injection grid shall consist of multiple lances each featuring multiple spray nozzles to enable proper ammonia distribution across the exhaust gas profile.



- B. Lances and supply header shall be constructed of 304 stainless steel. Each lance shall feature an isolation valve, metering orifice and differential pressure indication for balancing flows.
- C. The design of the SCR Catalyst bed shall be at the Manufacturer's discretion to meet the specified performance requirements but must be appropriate for the installed temperature region and must conform to the overall dimension requirements specified herein.
- D. Catalyst Bed shall be designed for a minimum guaranteed life span of 3 years.

## **2.9 CO CATALYST:**

- A. The design of the CO Catalyst section be at the manufacturer's discretion to meet the specified performance requirements but must be appropriate for the installed temperature region and must conform to the overall dimension requirements specified herein. Coordinate with emission performance of CTG furnished.

## **2.10 STACK**

- A. The manufacturer shall size and provide a stack with internal flue to sit atop the economizer. The outer casing shall be A-36 carbon steel minimum of 1/4 inches thick. Internal flue shall be 304 stainless steel and 18 Gauge. Flue is to be insulated with minimum 2 inch thick, 3# C.F. fiberglass including accessible exterior sections (provide suitable weather proofing and jacketing). The stack is to be mounted on top of the economizer outlet transition and terminating at an elevation above the Cogeneration Plant roofline as noted on plans. The entire length of stack above the top of the economizer outlet transition should be assumed to be outdoors. Refer also to Section 23 07 11, HVAC AND COGENERATION PLANT INSULATION.
- B. The manufacturer shall provide a support assembly, fabricated from structural I-beams and channels to support the economizer, ductwork and stack from the operating floor at the boiler baseline. The stack shall be totally self supporting without use of guy wires.
- C. Two (2) 6 inch flanged EPA test ports and two 3 inch flanged CEMS port are to be provided in the boiler stack. Ports shall be located an adequate distance above the nearest flow disturbance to assure accurate measurement. Ports shall to be compliant with EPA requirements. In addition, two (2) 4 inch flanged Opacity monitoring ports shall be confirmed and provided if required by EPA Air Permit for the boiler stack.
- D. All interior and exterior surfaces of the outer casing are to be prepared to SSPC-6 specification. Apply one coat of zinc-enriched primer, minimum 3 mils. Apply one final coat, minimum 3 mils thickness.

## **2.11 INSTRUMENTATION AND CONTROLS**

- A. The Cogeneration Plant Building, in which the steam generator will be incorporated, shall be equipped with a plant-wide Supervisory Control and Data Acquisition (SCADA) system or PLC. The HRSG package PLC shall be based

on the same system for compatibility. The Steam Generator Combustion Control and Burner Management System panels shall be fully capable of independent operation and shall have an EtherNet/IP communication link to the SCADA system for safe and reliable supervisory control, monitoring, alarming, data storage and trending, and optimization of the plant operations under all conditions.

- B. Control Philosophy: The intent of the PLC-based Combustion Control System and Burner Management System is to have complete control and monitoring of each HRSG to be done via local control panels (adjacent to the Manufacturer's equipment). The HRSG controls will be interfaced with the corresponding turbine generator controls for sequencing of startup and shutdown. The HRSG controls will be interfaced with a separate plant-wide control system for remote monitoring and supervisory control.
- C. All controls provided with the HRSG System shall include all necessary hardware, software, listing of addresses, etc. for implementing the Control Philosophy.
- D. Provide original licensed disks and original documentation for the development environments and runtime applications for all software furnished. Provide licensed copies of programming and configuration software for any programmable device such as PLCs and operator interface monitors.
- E. All instrumentation provided shall be "industrial/utility grade". All transmitters to be supplied with integral valve manifold (2-valve, 3-valve or 5-valve as most appropriate) and pipe mounting bracket for field mounting.
- F. All control valves shall be furnished with actuators and Digital Valve Controllers.
- G. Human-Machine Interface (HMI) to the PLC-based combustion control and burner management systems shall be via LCD color graphic touch screens where the various systems and control loops are presented in full graphic format.
- H. All combustion control and burner management control for each HRSG system shall be enclosed in a suitable NEMA 4 panel, with hinged door and lock, containing all necessary PLC components, relays, terminal blocks, fuse blocks, fuses, power supply, switches, and colored indicating lights. All instruments on the panel front shall be identified by nameplate. All wire terminations shall be numbered in accordance with the applicable wiring diagram. All wiring shall conform to the National Electric Code.
- I. Operating and Safety Controls: The unit shall be provided with a full complement of operating and safety controls, consisting of but not less than the following items and features:
  - 1. The HRSG system shall be designed in accordance with the applicable code requirements of NFPA 85.
  - 2. Automatic gas-electric ignition system for burner pilot.
  - 3. A UL listed Burner Management System based on PLC to provide proper pre-combustion purge, ignition, start, stop, post-combustion purge

and safety shutdown, for gas firing. This BMS shall have Ethernet communication and shall be Manufacturer standard design.

4. Combustion Control System with three element boiler feed water control, based on the same type of PLC as BMS to provide HRSG steam drum level and boiler master pressure control.
  5. High pressure safety interlock for steam pressure control.
  6. Level column with probes and a separate auxiliary low-low level water safety cutoff for steam drum and momentary electrical bypass push-button for sight glass blowdown function.
  7. Instrument Air pressure safety switch.
  8. Turbine generator exhaust flue gas flow and temperature safety switches.
  9. The following valve trains shall be mounted adjacent to the burner. All electrical devices shall be pre-wired to terminals within a burner mounted junction box. The gas trains shall be made from Schedule 40 pipe. Sizes 2" and above shall be with butt welded fittings.
    - a. Each pilot gas train shall conform to Factory Mutual and NFPA-85 and be of the interruptible type consisting, as a minimum, of two (2) pilot gas solenoid block valves, one (1) pilot vent valve, one (1) manual shutoff valve, and a pilot gas pressure regulator.
    - b. Each main gas train shall conform to Factory Mutual and NFPA-85 and consist of, as a minimum, a fuel flow control valve, two (2) main gas block valves, one (1) vent valve, one (1) gas pressure regulator, one (1) gas pressure indicating transmitter, one (1) manual gas shutoff valve, high and low gas pressure switches and main gas train leak-test provisions.
  10. The fuel train shall be constructed with Schedule 40 piping and shall conform to Factory Mutual and NFPA-85 requirements.
  11. Electronic continuity tests shall be provided on all circuits to ensure minimal start up time.
- J. The following instrumentation shall be supplied by the Manufacturer:
1. Steam Drum Trim:
    - a. Water Column/Probes for Low-Low, Low, High, and High-High points.
    - b. Low-Low Level Cutout Switch.
    - c. Column & Cutout Switch BD Bypass Pushbutton.
    - d. Level Transmitter/Manifold.
    - e. Level Sight Glass.
    - f. Continuous Blowdown Valves.
    - g. Intermittent Blowdown Valves.
    - h. Chemical Feed Valves.
    - i. Steam Pressure Indicating Transmitter.
    - j. High Steam Pressure Switch.
    - k. Excess (High-High) Steam Pressure Switch.
    - l. Steam Pressure Gauge.
    - m. Vent Valve.

- n. Non-Return Valve.
  - o. Steam Shut-off Valve.
  - p. Steam Flow Element.
  - q. Steam Flow Indicating Transmitter with Manifold.
  - r. Safety Valves.
2. Combustion Air Duct Trim:
- a. Pressure and Flow Switch(s).
  - b. Temperature Switches.
3. Feedwater Trim:
- a. Shut-off Valve.
  - b. Check Valve.
  - c. Feedwater Flow Element.
  - d. Feedwater Flow Indicating Transmitter with Manifold.
  - e. Feedwater Flow Control Valve.
  - f. Feedwater Control Valve Manual Block & Bypass Valves.
  - g. Feedwater Gas Strainers/filters.
  - h. Feedwater Pressure Gauges.
  - i. Steam Pressure Indicating Transmitter.
  - j. High Steam Pressure Switch.
  - k. Excess (High-High) Steam Pressure Switch.
4. Main Fuel Gas Train:
- a. Main Gas Pressure Regulator.
  - b. Main Gas Pressure Indicating Transmitter.
  - c. Main Gas Flow Control Valve with low fire limit switch.
  - d. Main Gas Flow Element.
  - e. Main Gas Flow Indicating Transmitter with Manifold.
  - f. Main Gas Double Block & Bleed safety block valves with limit switches.
  - g. Main Gas Manual Shut-off Valve.
  - h. Main Gas High and Low Pressure Switches.
  - i. Main Gas Strainers/filters.
  - j. Main Gas Pressure Gauges.
5. Pilot Fuel Gas Train:
- a. Pilot Gas Pressure Regulator.
  - b. Pilot Gas Pressure Gauges.
  - c. Pilot Gas Double Block & Bleed safety block valves.
  - d. Pilot Gas Manual Shut-off Valve.
  - e. Flame Scanner Amplifier.
  - f. Ignition Transformer.
6. General Instrumentation:
- a. Local Pressure Gauges.
  - b. Local Temperature Gauges.
  - c. Flame scanners Cooling Air provisions.

- d. Strainers upstream of all Control Valves.
- 7. Burner Management System:
  - a. PLC and components.
  - b. Ethernet Data Communication.
  - c. Pre-wired Enclosure.
  - d. Human-Machine Interface screen, lights, buttons, etc.
  - e. Preloaded Software Logic.
- 8. Combustion Control System:
  - a. PLC and components.
  - b. Ethernet Data Communication.
  - c. Pre-wired Enclosure.
  - d. Human-Machine Interface screen, lights, buttons, etc.
  - e. Preloaded Software Logic.
- K. Burner Management System:
  - 1. A complete automatic Burner Management System shall be provided for safe operation of the burner.
  - 2. Logic provided with the burner management system shall:
    - a. Prevent the introduction of any igniter flame or main fuel flame to the furnace until the furnace, boiler passes and stack have been purged of all combustible gases.
    - b. Prevent the opening of the automatic shut-off fuel valves in the main fuel lines until the igniter flame is proven.
    - c. Limit the time for main fuel ignition to 10 seconds from the time the igniter flame is proven.
    - d. In the event of a flame failure, require an operator to manually reset the burner management controller prior to a restart.
  - 3. The locally mounted Burner Management System control panel shall contain all devices required. No field wiring shall be required except from terminal blocks to external equipment of turbine generator and combustion control. All electrical equipment shall be installed and tested at the factory while simulating complete operational sequence. All connections, terminals and wires shall be identified and marked with a number that can be cross referenced on a system drawing. This test may be witnessed by the RE or his representative.
- L. Combustion Control System:
  - 1. Combustion Control system shall be provided by Manufacturer to adjust fuel flow rate, as CTG exhaust gas flow mass and temperatures vary to prevent over temperature firing of the Duct Burner which may result in physical damage to the HRSG or excess steam pressure. The following minimum operating logic shall be implemented via Combustion Controls.
    - a. Steam Pressure Control.
    - b. Steam Flow Control.
    - c. Drum Level Control.
    - d. Feedwater Flow Control.

- e. Duct Firing Temp. Limiting Control.
- 2. The following hard-wired signals shall be included by the Manufacturer for interface between BMS and Combustion Control system.
  - a. Go to Purge Position.
  - b. Master Fuel Trip.
  - c. Release to modulate.
  - d. Go to Low Fire Position.

## **2.12 ELECTRICAL**

- A. Motors shall be selected in accordance with the driven equipment requirement. The continuous nameplate rating shall be 15 percent greater than the maximum brake horsepower required by the driven equipment. Service factor ratings shall not be used to meet this requirement.
- B. The Manufacturer shall be completely responsible for the selection and application of the motor drives, so that the driven equipment shall perform satisfactorily under the specified conditions. The design and construction of all motors shall be fully coordinated with the mounting arrangement, alignment, connection, endplay, direction of rotation, vibration and other applicable requirements of the driven equipment.
- C. Motor performance shall be coordinated with the required performance of the driven equipment. All motors shall have ratings suitable for the torque and WK2 characteristics of the driven equipment. The Design letter shall be in accordance with NEMA Standard MG1-1.12, and shall be furnished with the Motor Data Sheets.
- D. All AC motors 1/2 to 250 hp shall be premium-efficiency, constant-speed, squirrel-cage induction, TEFC, severe-duty (mill and chemical) type, rated 460 V, 3-phase, 60 Hz, with Class F insulation, and a 1.15 service factor. The motors shall have a corrosion-resistant nameplate, grease fittings, oversized conduit box and a corrosion-resistant paint system. Temperature rise above 40 Deg. C ambient throughout the motor shall not exceed NEMA specified values. Motors shall be designed, manufactured and tested per ANSI/NEMA Standards. The full-load efficiency index letter and power factor shall be stamped on the nameplate.
- E. Fractional-horsepower motors smaller than 1/2 hp shall be rated 115 V, single-phase, 60 Hz. Motors shall be totally enclosed, fan cooled, with Class "B" insulation or better and suitable for indoor/outdoor use.
- F. DC motors shall be rated 120 V, and shall be able to operate within a voltage range of 105 to 140 V dc.
- G. All AC motor-operated safety shutoff valves shall be rated 120V 1-phase, 60 Hz.
- H. Motor terminal box shall be provided with grounding terminals.
- I. Motors shall be painted per the manufacturer's standards.

- J. All motors shall be designed to provide a continuous horsepower output, equal to the rated horsepower multiplied by the 1.15 service factor, without exceeding the total limiting temperature rise for the insulation system and enclosure specified.
- K. All motors shall have a safe stall time equal to or greater than the maximum accelerating time under the minimum starting voltage conditions.
- L. Starting current at full-voltage shall not exceed 650 % of the motor full-load current for all AC motors. DC motors shall be rated for use with starters that limit the starting current to a maximum of 400 % of motor rated full-load current.

#### **2.13 CLEANING, PACKAGING AND TAGGING**

- A. All vessels, components and subassemblies shall be thoroughly cleaned of all water, sand, grease, oil and other foreign materials prior to shipment.
- B. All flanged openings shall be covered with 3/8 inch thick plywood flange protectors; threaded openings shall be protected with plastic end caps or plugs.
- C. All caps, plugs and flange covers shall be sealed with tape to provide a dust-tight closure.
- D. The equipment shall be suitably skidded, crated, boxed, sealed or otherwise protected from damage during shipment.
- E. Each separate shipping crate, box or skid shall be clearly and indelibly labeled with equipment tag numbers. Letters shall be a minimum of 1" high.
- F. Each piece of equipment identified with an equipment number shall have a 304 stainless steel nameplate permanently attached to it and containing the following information:
  - 1. Equipment number.
  - 2. Purchase order number and date fabricated.
  - 3. Manufacturer's name and address.
  - 4. Manufacturer's serial number and model number.
  - 5. Equipment Data: Maximum working pressure and temperature, operating volume, etc.
- G. All information shall be embossed on the nameplate or otherwise permanently affixed.
- H. Motor nameplates shall be the responsibility of the Manufacturer and shall contain the motor manufacturer's standard information.
- I. The cleaning and packaging requirements of this section are minimum standards to be followed. The Manufacturer shall submit in writing, his standard procedures for cleaning and packaging for Engineer's review. In addition, the Manufacturer shall submit written recommendations for field storage, both indoor and outdoor.

## **2.14 PAINTING**

- A. All components with carbon steel and iron surfaces shall be painted with one coat of zinc inorganic primer, followed by one finish coat of enamel. Color is to be approved by the RE or their representative. High temperature aluminum paint shall be used for uninsulated boiler components. Prior to painting, all surfaces shall be sandblasted to SSPC-SP6 or SP-3 as applicable. Color to be Manufacturer's standard. The Manufacturer shall include a suitable amount of paint for each finish coat for field touch-up work.

## **2.15 SPECIAL TOOLS**

- A. Deliver to the Contracting Officers Technical Representative (COTR)/Resident Engineer (RE) one set of special tools normally provided for the HRSG system proposed such as a drum manway wrench.

## **2.16 SPARE PARTS**

- A. Deliver to the Contracting Officers Technical Representative (COTR) / Resident Engineer (RE) one set of special tools normally provided for the HRSG system proposed such as a drum manway wrench.
- B. Fuel Trains:
  - 1. One assembly of electrodes, transformer, and high voltage cable with end connectors for the igniter.
  - 2. One of each type and size of main and pilot fuel motorized and solenoid automatic safety shut-off valves and automatic vent valves.
  - 3. One atomizing steam admission solenoid valve.
  - 4. Complete set of filter elements and gaskets for each gas filter for each boiler.
  - 5. Complete set of all gaskets for each edge-type oil filter for each boiler.
- C. HRSG, Duct Burner, Trim, Feedwater Control Valve:
  - 1. Drum handhole gaskets, three complete sets for HRSG.
  - 2. Sufficient glass inserts and gaskets to re-equip all water level gage glasses on HRSG.
  - 3. One set of drive belts for each belt-driven apparatus on duct burner as appropriate.
  - 4. Valve and actuator complete for electrically-operated feedwater control valve.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC .



- B. Boiler, Duct Burner and Economizer Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping.
- C. Drainage Facilities for Boiler Water Column, Gage Glass, Low Water Cutoffs, Water Level Alarms:
  - 1. After individual drain valves, combine all drains into one pipe with a sight flow indicator, gate valve and check valve. Pipe to boiler blowoff line.
  - 2. Locate and orient sight flow indicator on common drain line so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switch.
- D. Boiler Drum Level Transmitter for Feedwater Regulator System:
  - 1. Provide three-valve isolation and equalizing system rated for 1035 kPa (150 psi), 182 °C (360 °F).
  - 2. Provide valved drain on all level sensing lines. Connect to water column drain system upstream of sight flow indicator.
- E. HRSG Casing Flashing: Flash or seal all pipe penetrations in casing at steam drum to prevent leakage of water into boiler insulation.

### **3.2 CLEANING AND PROTECTION FROM CORROSION**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Boiler Cleaning:
  - 1. Upon completion of installation, the initial firing of the burner shall be performed to boil out, under supervision of boiler manufacturer, all internal surfaces with chemical solution recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Inspect internal surfaces for cleanliness. Then, drain and refill boiler with softened and treated water or place boiler in dry storage as specified below.
  - 2. Refer to the paragraph at the end of PART 3, Article, INSPECTION AND TESTS "Internal Inspection of Pressure Parts and Furnace", for the requirements for cleaning the boiler after the operational tests are completed.
- C. Protection from Corrosion:
  - 1. Protect the HRSG and duct burner from corrosion at all times.
  - 2. Dry Storage: When the boilers are not filled with water, protect with a dry storage method recommended by either the HRSG manufacturer or the ASME Code, Section VII.
  - 3. Wet Storage: If, after water is placed in the HRSG, it is not fired for equipment adjustment or testing for more than two weeks, the HRSG shall be protected with a wet storage method recommended either by the HRSG manufacturer or the ASME Code, Section VII. If HRSG are not

fired for equipment adjustment and testing for more than one month, drain the HRSG and place in dry storage.

4. Chemical Treatment: The quality of the water in the HRSG shall be maintained by a professional water treatment organization. This organization shall provide on-site supervision to maintain the required water quality during periods of boiler storage, operating, standby and test conditions. Furnish monthly reports, by the water treatment organization, to the Resident Engineer (RE). The Contractor shall provide all chemicals, labor and professional services until the boilers have been accepted by the Government for operation. All chemicals utilized must conform to FDA Regulation CFR 21, 173.310, guidelines applicable for steam used in food preparation.

### 3.3 INSPECTIONS AND TESTS

- A. The following tests and demonstrations, except pretests, must be witnessed by the RE or their representative and must prove that boilers, economizers, burners, controls, instruments, and accessories comply with requirements specified. When test results are not acceptable, corrections must be made and the test repeated at no additional cost to the Government. Pretests do not require the presence of the RE.
- B. Condition of HRSG, duct burner, catalyst/treatment system and Economizer. After Delivery, Rigging, Placement: After setting boiler on foundation and placing economizer on supports, and prior to making any connections to boiler and economizer, Contractor and RE jointly will inspect interior and exterior for damage. Correct damage by repair or replacement to achieve a like new condition. After completion of repairs, perform air pressure test of the boiler casing. The Contractor shall conduct these tests at no cost to the Government.
- C. Hydrostatic Tests:
  1. HRSG, Economizer: Conduct tests after the equipment is installed and connected for operation and prior to initial firing. Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors (NB). Test pressure shall be 150% of the design pressure of the boiler held for a period required by the inspector. Provide written certification of the satisfactory test, signed by the inspector. Correct any deficiencies discovered during the testing, and retest equipment until satisfactory results are achieved and are accepted by the inspector.
  2. HRSG External Piping (as defined by ASME B31.1, Power Piping):
    - a. Refer to Section 23 21 11, COGENERATION PLANT PIPING SYSTEMS.
    - b. Test may be conducted concurrently with boiler and economizer testing.
  3. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after the tests are complete.
- D. Boiler Steam Safety Valves:
  1. Test each safety valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test to verify that safety valves

have sufficient capacity to relieve full boiler output at maximum firing rate of burner. Tests shall be performed with boiler isolated from the main steam header and all generated steam exhausting through the safety valves.

2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psi).
3. Valve Blowdown Tolerance: Reset at not less than six percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.
4. Accumulation Test: With burner at high fire, the boiler pressure shall not rise more than six percent above the set pressure of the safety valve with the highest pressure setting and no more than six percent above the maximum allowable working pressure of the boiler.
5. Make repairs and adjustments in manner recommended by National Board (NB) Inspection Code, NB-23. Retest valves after completion of repairs and adjustments.

E. Shop Testing:

1. The Manufacturer shall provide for inspection and stamping required of the equipment in accordance with the requirements of the ASME Pressure Vessel Code, ASME B31.1 Power Piping Code, and applicable state and local code requirements.
2. The Purchaser and Engineer reserve the right to inspect the unit during fabrication at the Manufacturer's plant. Dates and times shall be mutually agreeable to the Manufacturer and the Engineer.
3. Inspection by the Engineer, or lack of, shall in no way relieve the Manufacturer of its responsibility to meet the requirements of the ASME Code, applicable state and local code requirements, and this specification.
4. All equipment and material shall be subject to the Manufacturer's standard shop tests in accordance with the applicable codes and this specification. Tests shall be carried out at the Manufacturer's facility during and after completion of the manufacture of component parts in accordance with requirement of ANSI/ASME Boiler and Pressure Vessel Code. Wherever not specified in the said regulations, the tests shall be carried out in accordance with the standards proposed by the Manufacturer and approved by the Engineer.
5. The Manufacturer shall specify that all shop tests to be performed comply with applicable requirements. The Manufacturer shall notify the Owner and Engineer no later than 5 working days prior to any testing, so that the Owner and/or Engineer may witness the testing.
6. As a minimum, the following shop tests shall be performed:
  - a. Hydrostatic pressure test of all pressure parts, piping, and valves in accordance with the ASME code.
  - b. All pressure-retaining finished welds shall be inspected using a non-destructive examination, as applicable by code for materials and welds, including 10 percent randomly tested by radiographic examination as required.
  - c. Calibration tests of final control elements.

- d. Simulation test of the burner management system equipment. All limit devices shall be set and tested, all circuitry shall be checked through and complete programming checks, including testing of flame detectors shall be done.
  - e. Leak testing of control valves as per ANSI.
  - f. Functional tests on all solenoid, motor operated and pneumatically actuated valves and control valves.
  - g. Pneumatic leak testing of all gas and air piping systems at one and one half times operating pressure for the duct burner (minimum 6 hours).
  - h. Any other tests deemed necessary by the Manufacturer and inspecting authority.
7. The Manufacturer shall make all necessary adjustments or modifications required if shop and/or field testing identifies performance or design deficiencies.
  8. Certified copies of all shop and field tests and examinations performed by the Manufacturer shall be provided to the Owner for record purposes. All test reports shall be countersigned by the inspecting authority where required by code.
- F. Field Testing and Preparation for Startup:
1. The Manufacturer shall submit procedures for field testing of items not covered by shop testing that are normally performed by others.
- G. Performance and Acceptance Testing:
1. Acceptance of the HRSG system by the RE or their representative shall be subject to a formal performance test at the site in accordance with ASME Power Test Codes, PTC 4.4, latest edition. The RE or their representative shall furnish water, power, and similar items incidental to the operation of the equipment, including regulation station personnel.
  2. The Manufacturer shall identify and provide all taps required in the Manufacturer's piping or equipment necessary to perform this testing. Additionally, the manufacturer shall identify any special requirements, such as, but not limited to, highly accurate flow nozzles, for this testing that need to be incorporated into the piping system design.
  3. Sufficient tests shall be run to determine actual performance of the unit under all guaranteed conditions. Requirement of the number of test runs and their duration will have to be agreed with the Engineer before conducting the tests. Such tests shall be conducted under conditions maintained as close to contract conditions as plant operations permit. Performance correction curves, which the Manufacture shall submit prior to testing, shall be used where necessary to correct variations in ambient temperature, fuel heating value, etc. Certified copies of all test data shall be submitted to the RE or their representative at completion of the tests.
  4. A functional test, as performed by and/or under the immediate on site direction of Manufacturer, ("Functional Test") for purposes of demonstrating that the equipment and systems in the Supplier's Scope

function as designed safely, reliably, and as part of an integrated Plant system in accordance with good engineering practice. These tests shall include normal operations, such as emergency trips.

5. All tests shall be performed with permanently installed Plant instrumentation.
6. At least 75 days prior to scheduled Acceptance Testing, the Manufacturer shall submit, for approval by the Engineer, a complete Acceptance Test procedure that defines details such as protocol, type of tests, measurements to be taken, sample calculations and correction formulas.
7. The Manufacturer shall furnish all connections and instruments necessary for conducting the tests that are not required for operation of the HRSG system, such as, but not limited to, turbine exhaust gas flow measurement.
8. All the above tests shall be performed by a third party Commissioning Agent at the time of plant commissioning. In case these tests reveal any deficiencies with Manufacturer's equipment, the Manufacturer shall be required to rectify the deficiencies promptly and at his expense, so that they can be accepted by the Engineer.

### **3.4 INSTALLATION, COMMISSIONING AND STARTUP SERVICES**

- A. The Manufacturer shall provide the necessary services to assist in the installation and assembly of the work provided and field commissioning and startup services to fully commission the equipment to achieve performance guarantees. This service shall include, but not be limited to, verification of proper installation, performance of all tests and procedures as stated in the startup and installation manuals, verification of the proper operation of the control panels to perform as designed, performance of all necessary adjustments and calibrations of all unit sensors and meters and necessary technical assistance to assure that the Manufacturer's equipment meets the performance guarantees. The Manufacturer shall make all reasonable efforts to ensure that the same service technician(s) are utilized for startup, training and commissioning for each of the Manufacturer's equipment packages (i.e. HRSG and duct burner) for the duration of the project.
- B. Provide written certification that the entire assembly has been coordinated to achieve the required performance and to provide the required features.

### **3.5 TRAINING**

- A. The Manufacturer shall provide on-site training for up to 5 operating and maintenance personnel. Instructions shall include, but not be limited to, training materials, hands-on and classroom instruction and complete review of all manuals. Classroom training shall be performed for two groups of personnel in a maximum of 2-8 hour daily sessions. The hands-on instructions shall include start-up, operation (normal and expected transients), shutdown and maintenance of all HRSG systems.

- B. Additional hands on training shall be provided on an informal basis, as time permits, by the Manufacturer's representative during plant start up and commissioning.

### **3.6 PERFORMANCE AND ACCEPTANCE TESTING:**

- A. Acceptance of the HRSB system by the RE or their representative shall be subject to a formal performance test at the site in accordance with ASME Power Test Codes, PTC 4.4, latest edition. The RE or their representative shall furnish water, power, and similar items incidental to the operation of the equipment, including regulation station personnel.
- B. The Manufacturer shall identify and provide all taps required in the Manufacturer's piping or equipment necessary to perform this testing. Additionally, the manufacturer shall identify any special requirements, such as, but not limited to, highly accurate flow nozzles, for this testing that need to be incorporated into the piping system design.
- C. Sufficient tests shall be run to determine actual performance of the unit under all guaranteed conditions. Requirement of the number of test runs and their duration will have to be agreed with the Engineer before conducting the tests. Such tests shall be conducted under conditions maintained as close to contract conditions as plant operations permit. Performance correction curves, which the Manufacturer shall submit prior to testing, shall be used where necessary to correct variations in ambient temperature, fuel heating value, etc. Certified copies of all test data shall be submitted to the RE or their representative at completion of the tests.
- D. A functional test, as performed by and/or under the immediate on site direction of Manufacturer, ("Functional Test") for purposes of demonstrating that the equipment and systems in the Supplier's Scope function as designed safely, reliably, and as part of an integrated Plant system in accordance with good engineering practice. These tests shall include normal operations, such as emergency trips.
  - 1. The functional test shall also include one hour each of unfired operation at 50 percent, 75 percent, and 100 percent load, as well as one hour each of fired operation with the duct burner at 10 percent, 25 percent, 50 percent, 75 percent, and 100 percent load.
- E. A four hour performance test without duct firing ("Unfired Performance Test") to demonstrate ability to maintain Guaranteed Steam output at specified temperature, pressure and dryness and to also run continuously for 24 hours without interruption.
- F. A four hour performance test with duct firing ("Fired Performance Test") to demonstrate ability to maintain Guaranteed Steam output at specified temperature, pressure and dryness continuously and to also run for 24 hours without interruption. (Depending upon timing for plant startup the Fired Performance Test may need to be deferred until the next heating season).
- G. A reliability test ("Reliability Test") to demonstrate ability to continuously run for five days. The Performance Test may be during the Reliability Test.

- H. All tests shall be performed with permanently installed Plant instrumentation.
- I. At least 75 days prior to scheduled Acceptance Testing, the Manufacturer shall submit, for approval by the Engineer, a complete Acceptance Test procedure that defines details such as protocol, type of tests, measurements to be taken, sample calculations and correction formulas.
- J. The Manufacturer shall furnish all connections and instruments necessary for conducting the tests that are not required for operation of the HRSG system, such as, but not limited to, turbine exhaust gas flow measurement.
- K. All the above tests shall be performed by a third party Commissioning Agent at the time of plant commissioning. In case these tests reveal any deficiencies with Manufacturer's equipment, the Manufacturer shall be required to rectify the deficiencies promptly and at his expense, so that they can be accepted by the Engineer.
  - 1. NOx emissions shall be tested with electronic analyzer reading in parts per million. Analyzer shall be calibrated at with certified test gas within three months prior to use and immediately after cell replacement. Analyzer shall be accurate to plus or minus 5 percent of reading. If local emissions authorities require different testing the more complete and time consuming of the two shall be utilized, and shall comply with local emissions testing criteria.
- L. Internal Inspection of Pressure Parts and Furnace:
  - 1. After all operational tests are satisfactorily completed, a Government retained licensed boiler inspector may be engaged by the RE to determine if the HRSG is free from corrosion and any other type of damage or defect.
  - 2. In preparation for the inspection, open all drum handholes and the furnace access opening, drain and clean the interior of all pressure parts and clean all soot and debris from the furnace.
  - 3. Any corrosion, damage or defect shall be corrected to a like new condition in the judgment of the boiler inspector.
  - 4. Hard carbonaceous deposits on heating surface or refractory are evidence of flame impingement and are not permitted. Remove all deposits, make corrections to burners and provide complete retest of boiler and burner performance.
  - 5. After the boiler inspector has approved the boiler, all handholes and furnace access openings shall be closed with new gaskets.
- M. Report: Furnish complete written report (three copies) that includes test data, calculations, results compared with requirements, list of personnel, and other pertinent information. Furnish report within three weeks after completion of tests.

### **3.7 STARTUP AND TESTING**

- A. The Manufacturer shall provide on-site training for up to 5 operating and maintenance personnel. Instructions shall include, but not be limited to,

training materials, hands-on and classroom instruction and complete review of all manuals. Classroom training shall be performed for two groups of personnel in a maximum of 2-8 hour daily sessions. The hands-on instructions shall include start-up, operation (normal and expected transients), shutdown and maintenance of all HRSG systems.

- B. Additional hands on training shall be provided on an informal basis, as time permits, by the Manufacturer's representative during plant start up and commissioning.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

### **3.8 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

### **3.9 DEMONSTRATION AND TRAINING**

- A. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

### **3.10 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 64 00**

**PACKAGED WATER CHILLERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Centrifugal water-cooled chillers, complete with accessories.
- B. Shall be manufactured by York per equipment schedule on Drawings, to match existing. No other manufacturers shall be considered.

**1.2 RELATED WORK**

- A. Section 00 72 00, GENERAL CONDITIONS.
- B. Section 01 00 00, GENERAL REQUIREMENTS.
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- D. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- E. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- F. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training
- G. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- J. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- K. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM: Interface requirements for chillers.
- L. Section 23 21 13, HYDRONIC PIPING.
- M. Section 23 21 23, HYDRONIC PUMPS.
- N. Section 23 23 00, REFRIGERANT PIPING.
- O. Section 23 31 00, HVAC DUCTS and CASINGS
- P. Section 23 65 00, COOLING TOWERS.

Q. Section 26 29 11, MOTOR STARTERS.

### **1.3 DEFINITION**

- A. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- B. BACNET: Building Automation Control Network Protocol, ASHRAE Standard 135.
- C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- D. FTT-10: Echelon Transmitter-Free Topology Transceiver.
- E. OSHPD: Office of Statewide Health Planning and Development.

### **1.4 PERFORMANCE REQUIREMENTS**

- A. Condenser-Fluid Temperature Performance:
  - 1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 50 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
  - 2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 55 deg F.
  - 3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
- B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to compensate for site altitude.
- C. Performance Tolerance: Comply with the following in lieu of ARI 550/590.
  - 1. Allowable Capacity Tolerance: One and one-half (1-1/2) percent below scheduled capacity.

### **1.5 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Mechanical equipment and components are to be seismically qualified/certified per ASCE 7-05, Chapter 13, and as clarified in the Office of Statewide Health Planning and Development (OSHPD) Code Application Notice (CAN) No. 2-1708A.5.
- B. Seismic Performance: Active equipment shall be special seismic certified utilizing shake table testing in accordance with ASCE 7-05, Section 13.2.5, using criteria applicable to IBC Seismic Design Category F. The unit supplied for installation in this Project shall not have been subjected to shake table testing. Testing shall be conducted at nationally recognized test laboratory acceptable to the VA. No alternate method of proving

compliance will be accepted for this Project. Components with hazardous components shall be certified by supplier as maintaining containment following the design earthquake analysis or by shake table testing as described above.

- C. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS for additional seismic performance criteria.

#### **1.6 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, and comply with the following.
- B. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.
- C. Comply with AHRI requirements for testing and certification of the chillers.
- D. Refer to paragraph, WARRANTY, Section 00 72 00, GENERAL CONDITIONS, except as noted below:
  - 1. Provide a 5-year motor, transmission, and compressor warranty to include materials, parts and labor.
  - 2. Warranty period shall commence upon acceptance of the Project by the Resident Engineer.
- E. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard
- F. Refer to ASHRAE Standard 15, Safety Standard for Refrigeration System, for refrigerant vapor detectors and monitor.

#### **1.7 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning, Heating and Refrigeration Institute (AHRI):
  - 1. 550/590-03 Standard for Water Chilling Packages Using the Vapor Compression Cycle
  - 2. 575-94 Methods for Measuring Machinery Sound within Equipment Space
- C. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- D. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 1. ANSI/ASHRAE-15-2007 Safety Standard for Mechanical Refrigeration Systems

2. ANSI/ASHRAE-135-2010 A Data Communication Protocol for Building Automation and Control Networks
- E. American Society of Mechanical Engineers (ASME):
  1. 2007 ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels - Division 1"
- F. American Society of Testing Materials (ASTM):
  1. C534/ C 534M-2008 Preformed, Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- G. National Electrical Manufacturing Association (NEMA):
  1. 250-2008 Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. National Fire Protection Association (NFPA):
  1. 70-2008 National Electrical Code
- I. Underwriters Laboratories, Inc. (UL):
  1. 1995-2005 Heating and Cooling Equipment

#### **1.8 SUBMITTALS**

- A. Submit in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data.
  1. Centrifugal water chillers, including motor starters, control panels, and vibration isolators, and remote condenser data shall include the following:
    - a. Rated capacity.
    - b. Pressure drop.
    - c. Efficiency at full load and part load without applying any tolerance indicated in the AHRI 550/590/Standard.
    - d. Refrigerant
    - e. Accessories.
    - f. Installation instructions.
    - g. Start up procedures.
    - h. Wiring diagrams, including factory-installed and field-installed wiring.
    - i. Sound/Noise data report. Manufacturer shall provide sound ratings. Noise warning labels shall be posted on equipment.
    - j. Refrigerant vapor detectors and monitors.
- C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- D. Run test report for all chillers.

- E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with AHRI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.
- F. Provide seismic restraints for refrigeration equipment to withstand seismic forces.
- G. Seismic Qualification: Submit proof of equipment qualification to requirements for Special Seismic Certification. See Seismic Performance Requirements article.
  - 1. Proof of qualification shall consist of certificate issued by testing laboratory, signed by both laboratory representative and equipment manufacturer.
  - 2. Alternate proof of qualification: OSHPD pre-approved equipment with OSHPD OPA number.
- H. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.9 DELIVERY, STORAGE AND HANDLING**

- A. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.
- B. Ship each oil-lubricated chiller with a full charge of oil.
- C. Package chiller for shipping in totally enclosed bagging.

#### **1.10 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

### **PART 2 - PRODUCTS**

#### **2.1 CENTRIFUGAL WATER-COOLED WATER CHILLERS**

- A. General: Chiller shall be manufactured by York to match the existing campus chilled water plant. Products from other manufacturers will not be

allowed. See article 2.2 for additional requirements. Chiller shall be factory-assembled and-tested, complete with evaporator, condenser, compressor, VSD, motor, starter, oil heater and cooler, economizer or intercooler, refrigerant piping, instrumentation and control piping, operating and safety controls mounted on the chiller, and other auxiliaries necessary for safe and proper operation of the unit. Chiller operation shall be fully automatic. Make provision for space and design piping layout to suit the connections.

- B. Performance: Provide the capacity as shown on the drawings. Part load and full load efficiency ratings of the chiller shall not exceed those shown on the drawings.
- C. Capacity of a single water-cooled chiller shall not exceed 1,250 Tons (Standard AHRI Conditions).
- D. Applicable Standard: Chillers shall be rated and certified in accordance with AHRI Standard 550/590. Chillers shall be AHRI stamped. Chiller efficiency shall comply with FEMP (Federal Energy Management Progress) requirements. —
- E. Acoustics: Sound pressure levels shall not exceed the following specified levels. The manufacturer shall provide sound treatment if required to comply with the specified maximum levels. Testing shall be in accordance with AHRI 575. Values are at 100 percent load.

OCTAVE BAND								Overall
63	125	250	500	1000	2000	4000	8000	dB(A)
75	80	81	80	76.5	76	70	70	82

- F. Chillers shall be open or hermetically sealed, using the following refrigerant: HFC-134a.
- G. Evaporator: Shell-and-tube type, constructed and tested and stamped in accordance with Section VIII D1 of ASME Boiler and Pressure Vessel Code where applicable for working pressure produced by refrigerant used and water system installed, but not less than 1035 kPa (150 psig) waterside working pressure. Shell shall be fabricated of carbon steel and shall have carbon steel tube sheets; drilled and reamed to accommodate the tubes. Tubes shall be externally and internally enhanced individually replaceable and shall be expanded full diameter into tube sheets, providing a leak proof seal. Intermediate tube supports sheets shall be provided as recommended by the manufacturer to minimize tube vibration, stress, and wear. Performance shall be based on a water velocity not less than 1 m/s (3 fps) nor more than 4 m/s (12 fps), and fouling factor of 0.0000176 m<sup>2</sup> degrees C (0.0001 hr. sq. ft. degrees F/Btu). Removable water box shall be constructed of steel. Design working pressure shall be 1035 kPa (150 psig) pressure tested at 150 percent of working pressure. Water nozzle connections shall be flanged or grooved mechanical joint.
- H. Condenser: Shell-and-tube type, constructed, tested, and stamped in accordance with applicable portions of Section VIII D1 of the ASME Boiler and Pressure Vessel Code, where applicable for working pressure produced

by the refrigerant used and water system installed, but not less than 1035 kPa (150 psig). Shell shall be fabricated of carbon steel and shall have carbon steel tube sheets; drilled and reamed to accommodate the tubes. Tubes shall be nonferrous metal, externally enhanced, and internally enhanced, individually replaceable, and shall be expanded full diameter into tube sheets, providing a leak proof seal. Intermediate tube support sheets shall be provided as recommended by the manufacturer to minimize tube vibration, stress and wear. Tubes shall fit tightly in the supports to prevent chafing due to vibration or pulsation. Performance of condenser shall be based on a water velocity not less than 1 m/s (3 fps) nor more than 4 m/s (12 fps), and a fouling factor of 0.000044 m<sup>2</sup> degrees C (0.00025 hr. sq. ft.) degrees F/Btu. Removable water box shall be constructed of steel. Design working pressure shall be 1035 kPa (150 psig) pressure tested at 150 percent of working pressure. Water nozzle connections shall be flanged or grooved mechanical joint.

- I. Insulation: Evaporator, suction piping, compressor, and all other parts subject to condensation shall be insulated with 40 mm (1.5 inch) minimum thickness of flexible-elastomeric thermal insulation, complying with ASTM C534.
- J. Motor Load Limiter: Provide a sensing and control system, which will limit maximum load current of compressor motor to a manually selectable percentage of 40 percent to 100 percent of full load current. System shall sense compressor motor current and limit it by modulating inlet guide vanes at the compressor, overriding other controls in their ability to increase loading, but not overriding their ability to reduce loading.
- K. Isolation Pads: Manufacturers standard.
- L. Refrigerant and Oil:
  - 1. Provide sufficient volume of dehydrated refrigerant and lubricating oil to permit maximum unit capacity operation before and during tests. Refrigerant charge lost during the warranty period due to equipment failure shall be replaced without cost to the Government.
  - 2. The manufacturer shall certify that chiller components, such as seals, o-ring, motor windings, etc, are fully compatible with the specified refrigerants.
- M. Service valves shall be provided to facilitate refrigerant reclaim/removal required during maintenance.
- N. Controls: Chiller shall be furnished with unit mounted, stand-alone, microprocessor-based controls in NEMA 1 enclosure, hinged and lockable, factory wired with a single point power connection and separate control circuit. The control panel provide chiller operation, including monitoring of sensors and actuators, and shall be furnished with light emitting diodes or liquid-crystal display keypad.
  - 1. The chiller control panel shall provide a relay output to initiate system changeover to free cooling. This relay shall be energized upon initiation of free cooling at the chiller control panel.

2. Leaving chilled water temperature reset, where specified in the control sequence, shall be based on return water temperature, outdoor temperature, or 4-20 MA or 0-10 VDC signal from a building automation system, as indicated on control diagrams.
3. Chillers shall be pre-wired to terminal strips for interlocked to other equipment.
4. Provide contacts for remote start/stop, alarm for abnormal operation or shut down, and for Engineering Control Center (ECC) interface.
5. Chiller control panel shall reside on the "BACnet network", and provide data using open protocol network variable types and configuration properties, BACnet interworking using ARCNET or MS/TP physical data link layer protocol for communication with existing "Siemens" building automation control system.
6. Auxiliary hydronic system and the chiller(s) shall be electronically interlocked to provide time delay and starting sequence as indicated on control drawings.
7. The chiller control panel shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows.
  - a. High pressure switch that is set to 20 psig (adjustable setting) lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
  - b. Motor surge pressure that is set at 95 percent of compressor RLA that will automatically unload the compressor to prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
  - c. Low pressure switch that is set at 5 PSIG above the factory low pressure switch that will automatically unload the compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.
  - d. In all the above cases, the chiller will continue to run, in an unloaded state and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
8. With variation of +/-10 percent of design flow per minute, chiller shall be able to maintain +/-0.5 degrees F leaving water temperature control. The chiller must be able to withstand a +/- 30 percent change in flow rate per minute without unit trip. Variations in the primary flow allow for optimal system efficiency, but the chiller must be able to maintain temperature control to help ensure occupant comfort.
9. The chiller control panel shall provide +/-0.5 degrees F leaving water temperature control during normal operation. The chiller shall provide multiple steps leaving chilled water temperature controller to minimize part load energy use and optimize leaving chilled water



temperature control. If manufacturer is unable to provide at least several steps of unloading, hot gas bypass shall be required to minimize loss of leaving water temperature control.

10. The chiller control panel shall provide a 2-minute stop-to-start and 5 minute start-to-start solid state timer. If the anti-recycle timers are longer than 5 minutes, then hot-gas bypass shall be provided to limit loss of leaving chilled water temperature control in low-load conditions.

## **2.2 YORK CENTRIFUGAL CHILLER**

- A. Manufacturer/Model: YORK MaxE Centrifugal Liquid Chilling-Unit(s) as indicated on the drawings.

1. Each unit shall produce a capacity of 900 tons, cooling 1348 gpm of water from 58.00 to 42.00 degrees F when supplied with 2036 gpm of condenser water at 73.00 degrees F. Power input shall not exceed 448 KW with an NPLV of 0.369. The cooler shall be selected for 0.00010 fouling factor and a maximum liquid pressure drop of 9.4 ft. Water side shall be designed for 150 psig working pressure. The condenser shall be selected for 0.00025 fouling factor and maximum liquid pressure drop of 15.4 ft. Water side shall be designed for 150 psig working pressure. Power shall be supplied to the compressor motor at 460 volts - 3 phase - 60 Hertz and controls at 115 volts - 1-phase - 60 Hertz. The chiller shall use R-134A.
2. Each unit will be completely factory-packaged including evaporator, unit mounted starter, condenser, sub-cooler, compressor, open motor, lubrication system, Optiview control center and all interconnecting unit piping and wiring. The chiller will be painted prior to shipment.
3. Performance will be certified in accordance with ARI Standard 550/590. Only chillers that are listed in the ARI Certification Program for Centrifugal and Rotary Screw Water Chillers are acceptable.
4. The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

- B. Compressor:

1. The compressor will be a single-stage centrifugal type powered by an open-drive electric motor. The housing will be fully accessible with vertical circular joints, with the complete operating assembly removable from the compressor and scroll housing. Compressor castings will be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for R-134A units. The rotor assembly will consist of a heat-treated alloy steel drive shaft and impeller shaft with a cast aluminum, fully shrouded impeller. The impeller will be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration-free operation. Insert-type journal and thrust bearings will be fabricated of aluminum alloy, precision bored and axially grooved.
2. Internal single helical gears with crowned teeth will be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear will be individually

mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal shall be provided in double bellows, double-seal, cartridge type. A gravity-fed oil reservoir will be built into the top of the compressor to provide lubrication during coastdown in the event of a power failure.

3. Capacity control will be achieved by use of prerotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550/590. Prerotation vane position will be automatically controlled by an external electric actuator to maintain constant leaving chilled water temperature.

C. Lubrication System:

1. Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. Compressor shall have an auxiliary reservoir to provide lubrication during coastdown in the event of a power failure.
2. An oil reservoir, separate from the compressor, shall contain the submersible 2 HP oil pump and a 3000 watt oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be designed in accordance with applicable pressure vessel code and listed as part of the chiller by a nationally recognized testing laboratory.
3. Oil shall be filtered by an externally mounted 1/2 micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled oil cooler, with all piping factory installed. Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

D. Motor Driveline:

1. The compressor motor will be an open drip-proof, squirrel cage, induction type operating at 3570 RPM.
2. The open motor shall be provided with a D-flange, bolted to a cast iron adapter mounted on the compressor to allow the motor to be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.
3. Motor drive shaft will be directly connected to the compressor shaft with a flexible disc coupling. Coupling will have all metal construction with no wearing parts to assure long life, and no lubrication requirements to provide low maintenance.
4. Overload/overcurrent transformers will be furnished with all units.

E. Evaporator:

1. Evaporator will be of the shell-and-tube, flooded type designed for 235 psig working pressure on the refrigerant side. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII-Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 fps. Two liquid level sight glasses will be located on the side of the shell to aid in determining proper refrigerant charge. Suction baffles will be located above the tube bundle to prevent liquid refrigerant carryover to the compressor. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration.
2. Stubout water connections having victaulic grooves shall be provided.

F. Condenser:

1. Condenser will be of the shell-and-tube type, designed for 235 psig working pressure on the refrigerant side. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section VIII- Division 1. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 12 fps.
2. Stubout water connections having victaulic grooves shall be provided.

- G. Refrigerant Flow Control: Refrigerant flow to the evaporator will be controlled by a variable orifice for improving unloading capabilities.

H. Graphic Control Center:

1. General: The chiller shall be controlled by a stand-alone microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.
2. Control Panel: The control panel shall include a 10.4 in. diagonal color liquid crystal display (LCD) surrounded by "soft" keys which are redefined based on the screen displayed at that time. This shall be mounted in the middle of a keypad interface and installed in a locked enclosure. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major

components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units. Freeze point protection shall run the chiller at 36 degrees F leaving chilled water temperature, and not have nuisance trips on low water temperature. The program and sensor shall monitor the chiller water temperature to prevent freeze up. Provide hot gas bypass. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits. The chiller control panel shall also provide:

- a. System operating information including:
  - 1) Return and leaving chilled water temperature.
  - 2) Return and leaving condenser water temperature.
  - 3) Evaporator and condenser saturation temperature.
  - 4) Differential oil pressure.
  - 5) Percent motor current.
  - 6) Evaporator and condenser saturation temperature.
  - 7) Compressor discharge temperature.
  - 8) Oil reservoir temperature.
  - 9) Compressor thrust bearing positioning and oil temperature.
  - 10) Operating hours.
  - 11) Number of compressor starts.
- b. Digital programming of setpoints through the universal keypad including:
  - 1) Leaving chilled water temperature.
  - 2) Percent current limit.
  - 3) Pull-down demand limiting.
  - 4) Six-week schedule for starting and stopping the chiller, pumps and tower.
  - 5) Remote reset temperature range.
- c. Status messages indicating:
  - 1) System ready to start.
  - 2) System running.
  - 3) System coastdown.
  - 4) System safety shutdown-manual restart.
  - 5) System cycling shutdown-auto restart.
  - 6) System prelube.
  - 7) Start inhibit.
- d. The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity: red for safety fault, orange for cycling faults, yellow for warnings, and green for normal messages.

- e. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:
  - 1) Evaporator - low pressure.
  - 2) Evaporator - transducer or leaving liquid probe.
  - 3) Evaporator - transducer or temperature sensor.
  - 4) Condenser - high pressure contacts open.
  - 5) Condenser - high pressure.
  - 6) Condenser - pressure transducer out of range.
  - 7) Auxiliary safety - contacts closed.
  - 8) Discharge - high temperature.
  - 9) Discharge - low temperature.
  - 10) Oil - high temperature.
  - 11) Oil - low differential pressure.
  - 12) Oil - high differential pressure.
  - 13) Oil - sump pressure transducer out of range.
  - 14) Oil - differential pressure calibration.
  - 15) Oil - variable speed pump - pressure setpoint not achieved.
  - 16) Control panel - power failure.
  - 17) Motor or starter - current imbalance.
  - 18) Thrust bearing - proximity probe clearance.
  - 19) Thrust bearing - proximity probe out - of - range.
  - 20) Thrust bearing - high oil temperature.
  - 21) Thrust bearing - oil temperature sensor.
  - 22) Watchdog - software reboot.
  - 23) Safety shutdowns with a VSD shall include:
    - a) VSD shutdown - requesting fault data.
    - b) VSD - stop contacts open.
    - c) VSD - 105% motor current overload.
    - d) VSD - high phase A, B,C inverter heatsink temp.
    - e) VSD - high converter heatsink temperature.
    - f) Harmonic filter - high heatsink temperature.
    - g) Harmonic filter - high total demand distribution.
- f. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:
  - 1) Multi-unit cycling - contacts open.
  - 2) System cycling - contacts open.
  - 3) Oil - low temperature differential.
  - 4) Oil - low temperature.
  - 5) Control panel - power failure.
  - 6) Leaving chilled liquid - low temperature.
  - 7) Leaving chilled liquid - flow switch open.

- 8) Motor controller - contacts open.
- 9) Motor controller - loss of current.
- 10) Power fault.
- 11) Control panel - schedule.
- 12) Starter - low supply line voltage.
- 13) Starter - low supply line voltage.
- 14) Proximity probe - low supply voltage.
- 15) Oil - variable speed pump - drive contacts open.
- 16) Cycling shutdowns with a VSD shall include:
  - a) VSD shutdown - requesting fault data.
  - b) VSD - stop contacts open.
  - c) VSD initialization failed.
  - d) VSD - high phase A,B,C instantaneous current.
  - e) VSD - phase A,B,C gate driver.
  - f) VSD - single phase input power.
  - g) VSD - high DC bus voltage.
  - h) VSD - pre charge DC bus voltage imbalance.
  - i) VSD - high internal ambient temperature.
  - j) VSD - invalid current scale selection.
  - k) VSD - low phase A, B, C inverter heatsink temp.
  - l) VSD - low converter heatsink temperature.
  - m) VSD - pre-charge - low DC bus voltage.
  - n) VSD - logic board processor.
  - o) VSD - run signal.
  - p) VSD - serial communications.
  - q) Harmonic filter - logic board or communications.
  - r) Harmonic filter - high DC bus voltage.
  - s) Harmonic filter - high phase A, B, C current.
  - t) Harmonic filter - phase locked loop.
  - u) Harmonic filter - precharge - low DC bus voltage.
  - v) Harmonic filter - DC bus voltage imbalance.
  - w) Harmonic filter - 110 percent input current overload (filter option only).
  - x) Harmonic filter - logic board power supply.
  - y) Harmonic filter - run signal.
  - z) Harmonic filter - DC current transformer 1.
  - aa) Harmonic filter - DC current transformer 2.
- g. Security access to prevent unauthorized change of setpoints, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.
- h. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend up to 6 different

- parameters from a list of over 140, without the need of an external monitoring system.
- i. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller due to AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 11 years with power removed from the system.
  - j. A fused connection through a transformer in the compressor motor starter to provide individual over-current protected power for all controls.
  - k. A numbered terminal strip for all required field interlock wiring.
  - l. An RS-232 port to output all system operating data, shutdown / cycling message, and a record of the last ten cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print from one minute to one day.
  - m. The capability to interface with a building automation system to provide:
    - 1) Remote chiller start and stop.
    - 2) Remote leaving chiller liquid temperature adjust.
    - 3) Remote current limit setpoint adjust.
    - 4) Remote ready to start contacts.
    - 5) Safety shutdown contacts.
    - 6) Cycling shutdown contacts.
    - 7) Run contacts.
- I. Startup and Operator Training: The services of a factory trained, field service representative will be provided to supervise the final leak testing, charging and the initial startup and conduct concurrent operator instruction.
- J. Factory Insulation: Factory-applied, anti-sweat insulation will be attached to the cooler shell, flow chamber, tube sheets, suction connection, and (as necessary) to the auxiliary tubing. The insulation will be a flexible, closed-cell plastic type, 3/4 inch thick, applied with vapor-proof cement. The insulation will normally prevent sweating in environments with relative humidities up to 75 percent and dry bulb temperatures ranging from 50 to 90 degrees F.
- K. Factory Performance Testing: A factory performance test will be performed in accordance with the most recent ARI Standard. This is a test to demonstrate submitted unit performance. ARI tolerance shall be adjusted as indicated in article 1.4C.
- L. Isolation Mounting: Included with the unit are four vibration isolation mounts, consisting of 1 inch thick neoprene isolation pads, for field mounting. The pads are to be mounted under the steel mounting pads on the tube sheets. Suitable for ground floor installation.

- M. Shipment Form No. 2: The unit shall be completely assembled, with all main, auxiliary and control piping installed, controls wired, leak and air run test completed, and charged with dry nitrogen (2 to 3 psig). The oil charge and miscellaneous materials shall be packed separately. The refrigerant charge shall be shipped concurrently or separately in cylinders for field evacuation and charging of unit.
- N. Compressor Motor Starter: A variable speed drive will be factory installed on the chiller. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.
1. Drive will be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds.
  2. The variable speed drive will be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. The entire chiller package will be UL listed.
  3. The following features will be provided:
    - a. Door interlocked circuit breaker capable of being padlocked.
    - b. UL listed ground fault protection.
    - c. Over voltage and under voltage protection.
    - d. 3-phase sensing motor over current protection.
    - e. Single phase protection.
    - f. Insensitive to phase rotation.
    - g. Over temperature protection.
    - h. Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self-diagnostic service parameters. Separate meters for this information will not be acceptable.
    - i. KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically +/- 3 percent of reading. KW meter scale is 0 - 788 KW.
    - j. KWh Meter - The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is resetable and its accuracy is typically +/- 3 percent of reading. KWh meter scale is 0 - 999,999 kWh.
    - k. Ammeter - Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3 percent of reading. Ammeter scale is 0 - 545 A RMS.
    - l. Voltmeter - Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3 percent of reading. Voltmeter scale is 0 - 670 VAC.



- m. Elapsed Time Meter - Digital readout of the unit's elapsed running time (0 - 876,600 hours, resetable) is displayed via the unit control panel.
- 4. A harmonic filter that limits electrical power supply distortion for the variable speed drive to comply with the guidelines of IEEE Std. 519-1992 will be provided. The filter will be unit mounted within the same NEMA-1 enclosure and will be UL listed. The following digital readouts shall be provided at the chiller unit control panel as part of the filter package; input KVA, total power factor, 3 phase input voltage, 3 phase input current, 3 phase input voltage total harmonic distortion (THD), 3 phase current total demand distortion (TDD), self diagnostic service parameters. Separate meters for this information will not be acceptable.
- O. Motor: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Compressor motor furnished with the chiller shall be in accordance with the chiller manufacturer and the electrical specification Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT. Starting torque of the motor shall be suitable for the driven chiller machine.
- P. Motor Starter: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide a starter for each centrifugal chiller in NEMA I enclosure, designed for floor or unit mounting. For floor mounted starter provide wiring from starter to chiller. Starter shall be a variable frequency drive type. Provide starter with the following features in addition to the ones specified in Electrical Specification Section 26 29 11, MOTOR STARTERS.
  - 1. Starter shall include incoming line provision for the number and size cables shown on the drawings. Incoming line lugs shall be copper mechanical type.
  - 2. Terminals connection pads shall be provided to which customers supply lugs can be attached.
  - 3. Starters shall be coordinated with chiller packages(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagram.
  - 4. Contactors shall be sized per NEMA requirements to the chillers for full load currents.
  - 5. Ammeter(s) shall be provided, capable of displaying current to all three phases. Ammeter shall be calibrated so that inrush current can be indicated.
  - 6. Chiller starter shall include an advanced motor protection system incorporating electronic three phase overloads and current transformers. This electronic motor protection system shall monitor and protect against the following conditions:
    - a. Three phase loss with under and over voltage protection.
    - b. Phase imbalance.
    - c. Phase reversal.
    - d. Motor overload.
    - e. Motor overload protection incorrectly set.

- f. Momentary power loss protection with auto restart consisting of three phase current sensing device that monitor the status of the current.
  - g. Starter contactor fault protection.
  - h. Starter transition failure.
  - i. Distribution fault protection.
- 7. When a motor driven oil pump is furnished, provide a 120- volt control circuit, mounted within starter enclosure. When an oil pump starter is provided at the refrigeration machine, provide fused disconnect in star delta starter for oil pump.
- 8. The starter shall be equipped with pilot relays to initiate the start sequence of compressor. These relays shall be a self-monitoring safety circuit, which shall indicate improper operation (slow operation, welding of contacts, etc) and shall cause the chiller unit to be shut down and a fault trip indicator be displayed. The "starter circuit fault" indicator shall be located in the door of the enclosure and shall require manual reset.
- 9. A lockout transition safety circuit shall be provided to prevent damage from prolonged energization due to malfunction of the transistor contactor. Malfunction shall cause the chiller unit to shut down and the "starter circuit fault" indicator be displayed.
- 10. A permanent nameplate shall be provided and mounted on the starter panel. It shall identify the manufacturer, serial or model number identifying the date of manufacturing and component replacement parts, and all current and voltage rating, and as built wiring schematic showing all items provided.
- 11. Circuit breaker.

### **2.3 REFRIGERANT MONITORING AND SAFETY EQUIPMENT**

- A. General: Provide refrigerant monitoring sensor/alarm system and safety equipment as specified here. Refrigerant sensor and alarm system shall comply with ASHRAE Standard 15. The refrigerant monitoring system will be provided by the chiller manufacturer and shall be interfaced with the DDC control system.
- B. Refrigerant monitor shall continuously display the specific gas (refrigerant used) concentration; shall be capable of indicating, alarming and shutting down equipment; and automatically activating ventilation system. On leak detection by refrigerant sensor(s), the following shall occur:
  - 1. Activate machinery (chiller) room ventilation.
  - 2. Activate visual and audio alarm inside and outside of machinery room, with beacon light(s) and horn sounds equipment room and outside equipment room door(s). Shut down combustion process where combustion equipment is employed in the machinery room.
  - 3. Notify Engineering Control Center (ECC) of the alarm condition.
- C. Refrigerant monitor shall be capable of detecting concentration of 1 part per million (ppm) for low-level detection and for insuring the safety of

operators. It shall be supplied factory-calibrated for the apparent refrigerant.

- D. Monitor design and construction shall be compatible with temperature, humidity, barometric pressure, and voltage fluctuations of the machinery room operating environment.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might affect chiller performance, maintenance, and operation. Equipment locations shown on drawings are approximate. Determine exact locations before proceeding with installation.

#### **3.2 EQUIPMENT INSTALLATION**

- A. Install chiller on concrete base with isolation pads or vibration isolators.
  - 1. Concrete base is specified in Section 03 30 00, CAST-IN-PLACE CONCRETE
  - 2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
  - 3. Anchor chiller to concrete base according to manufacturer's written instructions and for seismic restraint on vibration isolators.
  - 4. Charge the chiller with refrigerant, if not factory charged.
  - 5. Install accessories and any other equipment furnished loose by the manufacturer, including remote starter, remote control panel, and remote flow switches, according to the manufacturer written instructions and electrical requirements.
  - 6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.
- B. Install refrigerant monitoring and safety equipment in accordance with ASHRAE Standard 15.
- C. Install refrigerant piping as specified in Section 23 23 00, REFRIGERANT PIPING and ASHRAE Standard 15.
- D. Install thermometers and gages as recommended by the manufacturer and/or as shown on drawings.
- E. Piping Connections:
  - 1. Make piping connections to the chiller for chilled water, condenser water, and automatic tube brush cleaning system and other connections as necessary for proper operation and maintenance of the equipment.

2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.
3. Extend vent piping from the relief valve or rupture disk and purge system to the outside.

### **3.3 STARTUP AND TESTING**

- A. Engage manufacturer's factory-trained representative to perform startup and testing service.
- B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.
- C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the VA that the equipment operate and perform as intended.
  1. Check refrigerant charge is sufficient and chiller has been tested for refrigerant leak.
  2. Check bearing lubrication and oil levels.
  3. Verify proper motor rotation.
  4. Verify pumps associated with chillers are installed and operational.
  5. Verify thermometers and gages are installed.
  6. Verify purge system, if installed, is functional and relief piping is routed outdoor.
  7. Operate chiller for run-in-period in accordance with the manufacturer's instruction and observe its performance.
  8. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller.
  9. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
  10. Prepare a written report outlining the results of tests and inspections, and submit it to the VA.
- D. Engage manufacturer's certified factory trained representative to provide training for 8 hours for the VA maintenance and operational personnel to adjust, operate and maintain equipment, including self-contained breathing apparatus.

### **3.4 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 65 00**

**COOLING TOWERS**

**1.1 DESCRIPTION**

- A. Packaged, induced draft open circuit cooling tower complete with fill, fan, inlet louvers and associated accessories and equipment.

**1.2 RELATED WORK**

- A. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- B. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- C. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- D. Section 03 30 00, CAST IN PLACE CONCRETE: Requirements for concrete inertia bases.
- E. Seismic Restraint for Equipment: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Section 23 05 11, COMMON Work Results for HVAC: General mechanical requirements and items, which are common to more than one item.
- G. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Requirements for vibration isolation.
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- I. Section 23 21 13, HYDRONIC PIPING: Requirements for water piping and fittings.
- J. Section 23 25 00, HVAC WATER TREATMENT: Requirements for condenser water treatment.
- K. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for sheet metal ductwork.
- L. Section 26 29 11, MOTOR STARTERS.

**1.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Mechanical equipment and components are to be seismically qualified/certified per ASCE 7-05, Chapter 13, and as clarified in the Office of Statewide Health Planning and Development (OSHPD) Code Application Notice (CAN) No. 2-1708A.5.

- B. Seismic Performance: Active equipment shall be special seismic certified utilizing shake table testing in accordance with ASCE 7-05, Section 13.2.5, using criteria applicable to IBC Seismic Design Category F. The unit supplied for installation in this Project shall not have been subjected to shake table testing. Testing shall be conducted at nationally recognized test laboratory acceptable to the VA. No alternate method of proving compliance will be accepted for this Project. Components with hazardous components shall be certified by supplier as maintaining containment following the design earthquake analysis or by shake table testing as described above.
- C. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS for additional seismic performance criteria.

#### **1.4 QUALITY ASSURANCE**

- A. Refer to Article, QUALITY ASSURANCE, in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Design Criteria:
  - 1. Design to withstand 1436 Pa (30 psf) wind load. Free water drift loss shall not be greater than five hundredths of one percent (0.005) of the water circulated to tower.
  - 3. Sound levels at 1.5 meters (5 feet) and 17 meters (55 feet) in any direction from the tower shall not exceed 83 dB (A) and 83 dB (A), respectively. Select "low Noise" model cooling towers, where available. Provide sound attenuators if necessary to meet the noise criteria.
- C. Performance Criteria:
  - 1. Manufacturer shall certify that performance of cooling towers will meet contract requirements, stating entering air wet bulb temperature, entering and leaving condenser water temperatures, water flow rates, fan kW (horsepower), and pump head at base of tower. Certification shall be made at the time of submittal.
  - 2. Cooling Technology Institute (CTI) Certified Towers: These towers shall have been tested, rated, and certified in accordance with Cooling Technology Institute (CTI) Standard 201, and shall bear the CTI certification label, and shall be listed in the CTI directory of certified cooling towers.
  - 3. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.



B. Shop Drawings

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include rated capacities, pressure drop, fan performance and rating curves, dimensions, weights, mounting details, front view, side view, equipment and device arrangement.
3. Include electrical rating, detail wiring for power, signals and controls.
4. Sound curves and characteristics of sound attenuators if required to meet the noise criteria.

C. Certification:

1. Submit four copies of performance curves, for CTI certified cooling towers, showing compliance with actual conditions specified, to the Resident Engineer two weeks prior to delivery of the equipment.
2. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
  - a. Certification by the manufacturer that the cooling towers conform to the requirements of the drawings and specifications.
  - b. Certification by the Contractor that the cooling towers have been installed, adjusted, and tested.

D. Seismic Qualification: Submit proof of equipment qualification to requirements for Special Seismic Certification. See Seismic Performance Requirements article.

1. Proof of qualification shall consist of certificate issued by testing laboratory, signed by both laboratory representative and equipment manufacturer.
2. Alternate proof of qualification: OSHPD pre-approved equipment with OSHPD OPA number.

E. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- B. American National Standard Institute (ANSI/ASSE):
  - 1. A10.18-2007 Safety Requirements for - Temporary Floors, Holes, Wall Openings, Stairways and Other Unprotected Edges in Construction and Demolition Operations
- C. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- D. American Society of Mechanical Engineers (ASME):
  - 1. PTC 23-03 Performance Test Codes on Atmospheric Water Cooling Equipment
- E. American Society for Testing Materials (ASTM):
  - 1. A653-07 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
  - 2. A666-10 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
  - 3. E84-08a Standard Test Method for Surface Burning Characteristics of Building Materials
- F. Cooling Technology Institute (CTI):
  - 1. ATC-105-00 Acceptance Test Code for Water-Cooling Towers (CTI Code Tower Standard Specifications)
  - 2. 201-02 (Rev. 04) Standard for Certification of Water Cooling Tower Thermal Performance (CTI Code Tower Standard Specifications)
- G. National Electrical Manufacturers Association (NEMA):
  - 1. MG 1-2006 Includes Motors and Generators (ANSI)
  - 2. 250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)
- H. National Fire Protection Association (NFPA):
  - 1. 70-08 National Electrical Code

## **1.7 DEFINITIONS**

- A. OSHPD: Office of Statewide Health Planning and Development

## **PART 2 - PRODUCTS**

### **2.1 INDUCED DRAFT OPEN CIRCUIT COOLING TOWER**

- A. Cooling tower shall be a factory assembled, induced draft, cross-flow type with a vertical discharge configuration.
- B. Casing: Heavy gage (minimum 16 gage) Stainless Steel
  - 1. Stainless Steel: ASTM A666, Type 304.

2. Fasteners: Zinc or cadmium coated bolts or tapping screws for assembly. Use stainless steel washers with neoprene backing where required for preventing leaks.
  3. Joints and seams: Sealed watertight.
  4. Welded connections: Continuous and watertight.
- C. Framing:
1. Rolled structural steel shapes, hot-dip galvanized after fabrication or structural shapes cold formed from galvanized steel sheets or plates, complying with ASTM A653/A653M, and having G235 (Z700) coating.
- D. Louvers:
1. Spaced to minimize air resistance and prevent splash out. Louver materials shall be similar to the casings or may be polyvinyl chloride (PVC) if formed integral with the fill material.
  2. 25 mm (1 inch) inlet screen, hot dipped galvanized steel. Attach the screen securely to air intakes.
- E. Fill:
1. PVC or FRP resistant to rot, decay and biological attack; with a maximum flame spread rating of five per ASTM E84 and fabricated, formed and installed by manufacturer to ensure that water breaks up into droplets.
- F. Drift Eliminators: Same as fill material. Effectively trap water droplets entrained in discharge air stream and limit drift loss to less than 0.005 percent of the total water circulated. Sections shall be assembled into easily removable racks of the same material as the casing. Eliminators can be PVC neoprene honeycomb type.
- G. Hot Water Distribution System: Open basin, flume and troughs, or a pipe system with nozzles spaced for even distribution of water over fill material. Provide access door. System shall be self-draining and non-clogging. Spray nozzles, if used, shall be cleanable stainless steel, bronze or high impact plastic, non-clog, removable type properly spaced for even distribution. Provide cover for entire nozzle area or flume/trough area. Provide manufacturer's standard pre-strainer assembly and butterfly or globe valve, for cross flow tower, to balance the water flow to each basin.
- H. Cold Water Collection Basin: stainless steel. Overflow, drain not less than DN (Deutsches Normung) 50 (NPS (Nominal Pipe Size) 2), and a 304 stainless steel strainer assembly with openings smaller than nozzle orifices and with built-in vortex baffling to prevent cavitation and air entrainment in the water basin circulating pump.
- I. Accessories: Make-up water, overflow and drain connections, Equalizer connection (multiple cooling tower systems) Flume plate between adjacent cells (multi-cell units only). Provide tower with internal piping, with connections for sump and hot basin below tower floor.

- J. Collection Basin Water Level Control: Electronic operated with slow closing 120V solenoid valve and NEMA MG 1, Type 4x enclosure. Solid state controls with stainless steel electrode probes and relays factory wired to a terminal strip to provide control of makeup valve and low and high level alarms and output for shutoff of pump on low level.
- K. Fans: Heavy duty axial flow type, belt or gear driven and balanced at the factory after assembly with cast aluminum or aluminum alloy blades driven by variable speed motor. The fan drive and moving parts shall be completely enclosed by removable hot-dip galvanized screens and panels complying with OSHA regulations. Fan shaft bearings of the self aligning, grease-lubricated ball or roller bearings with moisture proof seals and premium, moisture-resistant grease suitable for temperatures between minus 29 and 149 degrees C (minus 20 and plus 300 degrees F). Bearings designed for an L-10 life of 100,000 hours and with extended lubrication lines to an easily accessible location outside of the wet air stream. Provide access doors for inspection and cleaning.
- L. Motors and drives:
  - 1. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration limits specified in specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
  - 2. In addition to the requirements of specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC, the following shall apply:
    - a. Motors: Totally enclosed or epoxy encapsulated NEMA MG 1. Protect fan, bearings, and appurtenances from damage by weather, corrosion, water spray and grit. Provide motors with severe duty rating with the rotor and stator protected with corrosion-inhibiting epoxy resin, double shielded, vacuum-degassed bearings lubricated with premium moisture-resistant grease suitable for temperatures between minus 29 and plus 149 degrees C (minus 20 and plus 300 degrees F), and an internal heater automatically energized when motor is de-energized. Provide an adjustable motor base or other suitable provision for adjusting belt tension. Provide an adjustable motor base or other suitable provision for adjusting belt tension.
    - b. Fan shall be driven through a gear reducer, or driven by a V belt.
      - 1) Gear reducer drive: Specially designed for cooling tower operation, with dynamically balanced drive shaft assembly or shock absorbent flexible coupling requiring no lubrication, cast iron case with readily accessible oil drum and fill, and self-contained oil reservoir sealed against water entrance. Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the manufacturer's standard. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
      - 2) V Belt Drive: Fan shall be driven by a one-piece, multi-groove, neoprene/polyester belt, where this is the

manufacturer's standard. Belt drives shall be "V" type as specified in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Belt driven fan and motor shafts shall have taper-lock sheaves fabricated from corrosion resistant material.

- M. Motor Controllers: Provide variable speed motors and controllers, if shown on drawings for cooling tower fans. See specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC. In addition to the requirements of Section 23 05 11, COMMON WORK RESULTS FOR HVAC
  - 1. Lubrication fittings shall be readily accessible outside the wet air stream. Provide access doors for inspection and cleaning.
    - a. The alignment and balancing of the fans, motors and drive shaft as installed shall operate within the vibration tolerance specified in specification Section 23-05-41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- N. Fans over 1500 mm (60 inches) in diameter include a vibration cutout switch located in a protected position to effectively monitor fan vibration. Vibration switch shall be solid-state with adjustable time delay in NEMA 250, Type 4 enclosure. It shall stop fan motor under excessive fan vibration. Interface the vibration cut-out switch with the DDC control system to provide an alarm in the event the fans stop due to excessive vibration.
- O. Safety: Provide fan guards, ladders, handrails and platform in conformance with the ANSI A10.18 as follows:
  - 1. Fan Guard: Removable fan discharge with a rigid framed screen guard, installed over the fan cylinder.
  - 2. Ladders: Vertical hot-dip galvanized steel or aluminum ladder for each tower located outdoors. Ladders higher than 3.6 meters (12 feet) shall have safety cage. Ladders shall extend to within 300 mm (one foot) of the grade or the roof deck surface.
  - 3. Hand Railing: Steel or aluminum hand railings not less than 1070 mm (42 inches) high around perimeter of each fan-deck, or working surface 3.6 meters (12 feet) or more above ground, roof or other supporting construction. Handrails shall meet OSHA Standards.
  - 4. Platform: Galvanized steel with a bar grating floor.
  - 5. The catwalks, ladders, cages and railings shall conform to requirements of California OSHA for maintenance access.

## **2.2 CONTROL PANEL**

- A. Provide factory furnished control panel for each cooling tower.
- B. Control panel shall be a factory pre-wired NEMA 250 Type 3 - Drip-proof type enclosure, containing:
  - 1. Unfused disconnect switch.
  - 2. Fan motor variable speed drives/motor starters.
  - 3. Interlocks and relays.

4. Pilot lights and push buttons.
5. Provide contacts for remote start/stop and for Engineering Control Center (ECC) interface

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install cooling tower according to equipment manufacturer's written instruction.
- B. Install cooling towers plumb, level and anchored on structure provided. Coordinate steel structure with cooling tower mounting requirements. If installed on concrete base, refer to Division 3 of specification for concrete materials and installation requirements.
- C. Install vibration controls according to manufacturer's recommendations.
- D. Install anchor bolts to elevations required for proper attachment to supported equipment
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Piping:
  1. Install piping, including flanges or union adjacent to cooling towers to allow for service and maintenance.
  2. Install flexible pipe connectors at connections to cooling towers mounted on vibration isolators.
  3. Install shutoff/balancing valves at cooling tower inlet connections.
  4. Install piping adjacent to cooling towers to allow service and maintenance.
  5. Provide drain piping with valve at cooling tower drain connections and at low points in piping.
  6. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.
  7. Domestic Water Piping: Comply with applicable requirements in Section 22 11 00, FACILITY WATER DISTRIBUTION. Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
  8. Supply and Return Piping: Comply with applicable requirements in Section 23 21 13, HYDRONIC PIPING. Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a flange or grooved coupling.
  9. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower

connection, between tower cells. Connect to cooling tower with shutoff valve.

10. Connect sheet metal ducts to inlet and outlet of liquid tower if installed indoor. Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS, for compliance with material and installation requirements.

- G. Seismic Restraints: Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- H. Electrical Wiring: Install electrical devices, components and accessories furnished loose by manufacturer, including remote flow switches and variable frequency drives.

### **3.2 FIELD QUALITY CONTROL**

- A. Provide the services of an independent testing and inspection agency to perform the field tests and inspections of non-CTI certified cooling towers, 700 kW (200 tons) and larger, according to ASME PTC-23 "Performance Test Code on Cooling Tower Equipment" and Cooling Technology Institute ATC-105 for Cooling Towers. Submit qualification of the independent testing agency to the Resident Engineer two weeks prior to the inspection for approval.
- B. If the cooling tower does not meet the specified performance, the Contractor shall make the tower corrections necessary to bring the tower into compliance with the specified performance including replacing the tower if necessary. Additional tests will be required until the tower meets the specified performance. Costs for the tower corrections or replacement, and tests shall be borne by the Contractor. However, the VA will pay for the initial test, when requested, if the cooling tower of less than 200 tons meets the specified performance.

### **3.3 STARTUP AND TESTING**

- A. Provide the services of a factory-authorized and qualified representative to perform start up service.
- B. Clean entire unit including basin.
- C. Inspect field-assembled components and equipment installation, including piping and electrical connections.
- D. Verify that accessories are properly installed.
- E. Obtain and review performance curves and tables.
- F. Perform startup checks, according to manufacturer's written instructions, and as noted below:
  1. Check clearances for airflow and tower servicing.
  2. Check for vibration isolation and structural support.

3. Verify fan rotation for correct direction and for vibration or binding and correct problems.
  4. Adjust belts to proper alignment and tension.
  5. Lubricate rotating parts and bearings.
  6. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
  7. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
  8. Check vibration switch setting. Verify operation.
  9. Verify operation of basin heater and control.
  10. Operate equipment controls and safeties.
  11. Verify that tower discharge is high enough and it does not recirculate into HVAC air intakes. Recommend corrective action.
- G. Adjust water level for proper operating level and balance condenser water flow to each tower inlet.
- H. Check water treatment water system, including blow down for proper operation of the tower. Check makeup water-level control and valve.
- I. Start cooling tower, including condenser water pumps and verify the tower operation.
- J. Prepare and submit a written report of startup and inspection service to the Resident Engineer.
- K. Replace defective and malfunctioning units.

### **3.4 TRAINING:**

- A. Furnish the services of a competent, factory-trained engineer or technician for a 2-hour period for instructing VA personnel in operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the Resident Engineer. Coordinate this training with that of the chiller, if furnished together.

### **3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.



### **3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -



**SECTION 23 81 26**

**SPLIT-SYSTEM AIR CONDITIONERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section specifies electrically operated split-system air conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Definitions:
  - 1. Coefficient of Performance (COP) - Cooling: The ratio of the rate of heat removed to the rate of energy input in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
  - 2. Coefficient of Performance (COP) - Heating: The ratio of the rate of heat delivered to the rate of energy input in consistent units for a complete heat pump system, including the compressor and, if applicable, auxiliary heat under designated operating conditions.
  - 3. Energy Efficiency Ratio (EER): The ratio of net cooling capacity in Btu/h to total rate of electricity input in watts under designated operating conditions.
  - 4. Heating Seasonal Performance Factor (HSPF) - Total heating output of heat pump during its normal annual usage period for heating in Btu/h divided by total electric energy input in watts during the same period.
  - 5. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period.
  - 6. Air-Source Unitary Heat Pump: One or more factory made assemblies that normally include an indoor conditioning coil, compressor(s) and an outdoor refrigerant-to-air coil. These units provide both heating and cooling functions.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: For pre-test requirements.
- B. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- C. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- D. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.

- E. Section 03 30 00, CAST-IN-PLACE CONCRETE: Support pads for outdoor equipment.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- H. Section 23 23 00, REFRIGERANT PIPING: Requirements for field refrigerant piping.
- I. Section 23 31 00, HVAC DUCTS AND CASINGS: Requirements for sheet metal ductwork.
- J. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM: Requirements for controls and instrumentation.
- K. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.

### **1.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. Mechanical equipment and components are to be seismically qualified/certified per ASCE 7-05, Chapter 13, and as clarified in the Office of Statewide Health Planning and Development (OSHPD) Code Application Notice (CAN) No. 2-1708A.5.
- B. Seismic Performance: Active equipment shall be special seismic certified utilizing shake table testing in accordance with ASCE 7-05, Section 13.2.5, using criteria applicable to IBC Seismic Design Category F. The unit supplied for installation in this Project shall not have been subjected to shake table testing. Testing shall be conducted at nationally recognized test laboratory acceptable to the VA. No alternate method of proving compliance will be accepted for this Project. Components with hazardous components shall be certified by supplier as maintaining containment following the design earthquake analysis or by shake table testing as described above.
- C. See Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS for additional seismic performance criteria.

### **1.4 HAZARDOUS ENVIRONMENTS**

- A. Where fan/coil unit may be located in hazardous environment, Class 1, Groups B, C and D compliant equipment shall be provided.

### **1.5 QUALITY ASSURANCE:**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC
- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

- C. Comply with ASHRAE Standard 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings for cooling and heating performance requirements when tested in accordance with AHRI 210/240 or AHRI 340/360, as applicable for unit size as scheduled on Drawings and UL 1995.
- D. Heating Performance shall conform to ASHRAE requirements when tested in accordance with AHRI 210/240 or AHRI 340/360, as applicable for unit size as scheduled on Drawings and UL 1995.
- E. Comply with requirements in Section 13 05 41, Seismic Restraint Requirements for Non-Structural Components.
- F. Provide extended warranty covering all materials, parts and labor for compressors for a period of 5 years.

#### **1.6 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data.
  - 1. Split-system Air Conditioners
- C. Certification: Submit, simultaneously with shop drawings, a proof of certification that this product has been certified by AHRI.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required cooling and heating capacities EER and COP values as applicable.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.
- F. Seismic Qualification: Submit proof of equipment qualification to requirements for Special Seismic Certification. See Seismic Performance Requirements article.
  - 1. Proof of qualification shall consist of certificate issued by testing laboratory, signed by both laboratory representative and equipment manufacturer.
  - 2. Alternate proof of qualification: OSHPD pre-approved equipment with OSHPD OPA number.
- G. LEED Submittals: Submit in accordance with Section 01 81 11.
  - 1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - 2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

**1.7 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specification (Fed. Spec.):
  - 1. A-A-50502-90 Air-conditioner (UNITARY HEAT PUMP), AIR TO AIR (3000 TO 300,000 BTUH).
- C. Air-Conditioning Heating and Refrigeration Institute (AHRI) Standards:
  - 1. AHRI-DCPP Directory of Certified Product Performance - Applied Directory of Certified Products
  - 2. 210/240-08 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
  - 3. 270-08 Sound Rating of Outdoor Unitary Equipment
  - 4. 340/360-07 Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
- D. American Society of Civil Engineers (ASCE):
  - 1. ASCE 7-05 Minimum Design Loads for Buildings and Other Structures.
- E. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc (ASHRAE):
  - 1. 15-10 Safety Standard for Refrigeration Systems (ANSI)
  - 2. 62.1-10 Ventilation for Acceptable Indoor Air Quality (ANSI)
  - 3. 90.1-07 Energy Standard for Buildings except Low-Rise Residential Buildings
  - 4. 2008 Handbook HVAC Systems and Equipment
- F. American Society of Testing and Materials (ASTM):
  - 1. B117-09 Standard Practice for Operating Salt Spray (Fog) Apparatus
  - 2. D4587-11 Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
- G. National Electrical Manufacturer's Association (NEMA):
  - 1. MG 1-09 (R2010) Motors and Generators (ANSI)
  - 2. ICS 1-00 (R2005) Industrial Controls and Systems: General Requirements
- H. National Fire Protection Association (NFPA):
  - 1. 90A-09 Standard for the Installation of Air-Conditioning and Ventilating Systems

- I. Underwriters Laboratory (UL):
  - 1. 1995-05 Heating and Cooling Equipment

## **PART 2 - PRODUCTS**

### **2.1 SPLIT-SYSTEM AIR CONDITIONERS**

- A. Units shall comply with Fed Spec A-A-50502 Type II, (Split System) having remote outdoor section separate from indoor Section, Class 1, "Department of Energy" (DOE) covered products (units with cooling capacity up to 65000 Btu/hr , or Class 2, Non-DOE covered products (units with cooling capacity up to 300,000 Btu/hr., as applicable for unit size as scheduled on Drawings.
  - 1. Unitary heat pumps shall bear the United States Environmental Protection Agency, Energy Star label and shall have a minimum Heating Season Performance Factor (HSPF) of 8.2 (Type II - Split System), and a minimum Seasonal Energy Efficiency Ratio (SEER) of 14.5 (Type II - Split System).
- B. Applicable AHRI Standards: Units shall be listed in the corresponding ARI Directory of Certified products shown in paragraph, APPLICABLE PUBLICATIONS:
  - 1. Air Source Unitary heat pumps with capacity less than 19 KW (65,000 Btu/hr), Comply with AHRI 210/240.
  - 2. Air Source heat pump with capacity above 19KW (above 65,000 Btu/hr, Comply with AHRI 340/360.
- C. Casing: Unit shall be constructed of zinc coated, heavy-gage galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit surfaces shall be tested 500 hours in a salt spray test in compliance with ASTM B117. Cabinet panels shall have lifting handles and shall be water- and air-tight seal. All exposed vertical, top covers and base pan shall be insulated with 25-mm (1-inch matt-faced, fire-resistant, odorless, glass fiber material. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010. The base of the unit shall have provisions for forklift and crane lifting.
- D. Filters: One inch, MERV 7, throwaway filter shall be standard on all units below 19kW (6 Tons). Filter rack can be converted to two inch capability. Two inch, MERV 8, throwaway filters shall be factory supplied on all units above 19 kW (6 Tons).
- E. Compressors: Compressors shall be direct-drive, hermetic scroll type with centrifugal type oil pumps. Motor shall be suction gas-cooled. Internal overloads and crankcase heaters shall be utilized with all compressors.
- F. Refrigerant Circuit: Each refrigerant circuit shall have independent fixed orifice or thermostatic expansion devices, service pressure ports, and refrigerant line filter driers factory installed as standard. An area shall be provided for replacement suction line driers.

- G. Evaporator and Condenser Coils: Internally finned, DN 10 (NPS 3/8) copper tubes mechanically bonded to a configured aluminum plate fin shall be standard. The evaporated coil and condenser coil shall be leak tested at the factory to 1378 kPa (200 psig) and pressure tested to 2756 kPa (400 psig). All dual compressor units shall have intermingled evaporator coils. Sloped condensate drain pans shall be provided.
- H. Outdoor fans: Direct driven, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motors shall be permanently lubricated and shall have built-in thermal overload protection.
- I. Indoor Fan:
  - 1. Forward-Curved, Centrifugal Fan: Provide V-belt driven with adjustable motor sheaves. Motors shall be thermally protected. Provide oversized motors for high static application. Motors shall meet the U.S. Energy Policy Act of 2005 (EPACT). Provide TEFC explosion-proof motors and explosion-proof fans where scheduled on Drawings.
- J. Defrost Controls (Heat Pumps): A time initiated, temperature terminated defrost system shall ship with a setting of 70-minute cycle, with a choice of 50- or 90-minute cycle. Timed override limits defrost cycle to 10 minutes shall be available on units from 35- to 70-kW (10 to 20 tons). Adaptive demand defrost shall be provided on units below 35 kW (10 Tons).
- K. Unit Electrical
  - 1. Provide single point unit power connection.
  - 2. Unit control box shall be located within the unit and shall contain controls for compressor, reversing valve and fan motor operation and shall have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.
  - 3. Safety Controls - High pressure, low temperature, and low pressure safety switches shall be wired through a latching lockout circuit to hold the conditioner off until it is reset electrically be interrupting the power supply to the conditioner. All safety switches shall be normally closed, opening upon fault detection.
- L. Operating Controls
  - 1. Provide unit with controls as shown on Contract Drawings.
  - 2. Unit DDC Controller:
    - a. Unit controller shall include input, output and self-contained programming as needed for complete control of unit.
    - b. Unit controller shall be BAC net compliant and utilize BAC net operating protocol.
    - c. Control system shall seamlessly interface with temperature control system as specified in Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM without requiring gateways or any other interface devices.



- d. All program sequences shall be stored on board in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of logic controller shall be completely modifiable in the field over installed BACnet LANs.
- e. Temperature Control System Interface: Points shall be available from the unit controller for service access and display and/or control.
- f. Space Temperature Sensor: The wall mounted sensor shall include occupied and unoccupied setpoint control, pushbutton unoccupied override, space temperature offset and space temperature indication. Refer to Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM for additional requirements.

M. Accessories:

- 1. Electric Heater (if specified): Constructed of heavy-duty nickel chromium elements. Staging shall be achieved through the unit control processor. Each heater shall have automatically reset high limit control. Heaters shall be individually fused from the factory and shall comply with NEC and CEC requirements. Power assemblies shall provide single point connection. Electric heat modules shall be listed and labeled by a national recognized testing laboratory acceptable to authorities having jurisdiction. Electric heater controls shall confirm the supply fan is operating before electric elements are energized. Operate electric heater in 2 stages when outdoor ambient is too low to maintain space thermostat setting with compressor operation.
- 2. Economizer (if shown): Field installed; and shall include fully modulating 0-100 percent motor and dampers, barometric relief, minimum position setting and fixed dry bulb. Solid state enthalpy and differential enthalpy control shall be field-installed.

## 2.2 CORROSION PROTECTION

A. Remote Outdoor Condenser Coils:

- 1. Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprises of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. The coating thickness shall be maintained between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, they are treated to permeate immersion rinse and spray. Where the coils are subject to UV exposure, UV protection spray treatment comprising of UV-resistant urethane mastic topcoat shall be applied. Provide complete coating process traceability for each coil and minimum five years of limited warranty. The coating process shall be such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:
  - a. Salt Spray Resistance (Minimum 6,000 Hours)
  - b. Humidity Resistance (Minimum 1,000 Hours)

- c. Water Immersion (Minimum 260 Hours)
  - d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)
  - e. Impact Resistance (Up to 160 Inch/Pound)
- B. Exposed Outdoor Cabinet:
- 1. Casing Surfaces (Exterior and Interior): All exposed and accessible metal surfaces shall be protected with a water-reducible acrylic with stainless steel pigment spray-applied over the manufacturer's standard finish. The spray coating thickness shall be 2-4 mils and provide minimum salt-spray resistance of 1,000 hours (ASTM B117) AND 500 hours UV resistance (ASTM D4587).

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install split system air conditioners according to manufacturers printed instructions.
- B. Install electrical and control devices furnished by the manufacturer but not specified to be factory mounted. All electrical work shall comply with Division 26 Sections.
- C. Ductwork: Comply with requirements in Section 23 31 00, HVAC DUCTS AND CASINGS.
- D. Piping: Comply with requirements in Section 23 23 00, REFRIGERANT PIPING.

#### **3.2 STARTUP AND TESTING:**

- A. Perform startup checks according to manufacturer's written instructions.
- B. Test controls and demonstrate its compliance with project requirements. Replace damaged or malfunctioning controls and equipment and retest the equipment to the satisfaction of the Resident Engineer.
- C. Furnish test reports to the Senior Resident Engineer in accordance with specification Section 01 00 00, GENERAL REQUIREMENTS.

#### **3.3 INSTRUCTIONS**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of split system air conditioners.

#### **3.4 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

**3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS.

**3.7 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

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**SECTION 23 85 00**

**THERMAL ENERGY STORAGE TANK SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This specification describes a Thermal Energy Storage Tank for use in meeting air conditioning and/or process cooling loads. The tank storage system will employ the principle of thermal stratification for storing warm and cold water (or aqueous fluid) in a single storage vessel.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 23 24 01, THERMAL ENERGY STORAGE TANK SYSTEM PERFORMANCE TESTING.

**1.3 SCOPE**

- A. The work to be performed under these specifications includes furnishing all labor, materials, tools and equipment necessary to design, fabricate, construct, inspect and test a welded steel Thermal Energy Storage (TES) Tank System including the foundation, insulation and accessories as shown on the drawings and specified herein.
- B. The work shall also include all labor, materials and equipment necessary to clean and paint the thermal energy storage tank as specified herein.
- C. The tank shall be a vertical, cylindrical, flat bottom type of all-welded steel construction.
- D. All required testing shall be scheduled, coordinated and completed in the presence of the Resident Engineer, with testing reports due as submittals, but the testing process, work, tools, instruments and the like shall be provided by the Contractor.

#### **1.4 REFERENCES**

- A. The materials, design, fabrication, erection and inspection of the welded steel thermal energy storage tank and foundation, shall conform to the latest editions of the following Standards, Codes, and Guides:

#### **1.5 APPLICABLE PUBLICATIONS**

- A. American Concrete Institute (ACI):
1. ACI 318 Specification for Structural Concrete
- B. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
1. ASHRAE 2009 HVAC Fundamentals Handbook
  2. ASHRAE 2008 HVAC Systems & Equipment Handbook, Chapter 50, Thermal Storage
  3. ASHRAE Guide ASHRAE Design Guide for Cool Thermal Storage
- C. American Society of Mechanical Engineers (ASME):
1. ASME B31.1 Code for Pressure Piping - Power Piping
- D. American Water Works Association (AWWA):
1. AWWA D100 Welded Steel Tanks for Water Storage
  2. AWWA D102 Painting Steel Water Storage Tanks
- E. Air-Conditioning, Heating & Refrigeration Institute (AHRI)
1. Guideline T Specifying the Thermal Performance of Cool Storage Equipment
  2. AHRI Std 900 Thermal Storage Equipment Used for Cooling
- F. National Fire Protection Association (NFPA)
1. NFPA 780 Installation of Lightning Protection Systems
- G. Steel Structures Painting Manual and SSPC Standards, Volumes 1 and 2

#### **1.6 REQUIREMENTS**

- A. Pre-Qualification of TES Installing contractor (TESIC):
1. The TESIC must have a minimum of ten years experience in the turnkey design and supply of operating TES Tank Systems, including individual systems of at least 10,000 ton-hour capacity. The system and internals provided shall be of the TESIC's own design and shall utilize principles and details proven operationally successful by field installations.
  2. Upon request the TESIC shall provide a minimum of five references (with customer contacts) for similar, thermally-stratified, chilled water storage installations currently in service each utilizing modular internals of the TESIC's own design.

3. Upon request the TESIC shall provide a minimum of three successful performance test results for chilled water storage installations currently in service, each utilizing modular internals.
4. TESIC shall have experience in the turnkey design and supply of Factory Mutual approved dual-service, fire protection and chilled water storage, installations.

B. Geotechnical Investigation

1. The Owner or Engineer, upon request, shall provide an up-to-date soils investigation report furnished by a qualified Geotechnical Engineer, according to the "Guide for Soil Investigations" as supplied by the Contractor, no later than 14 days prior to the project bid date.

C. Submittals

1. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
2. The following Approval Drawings shall be certified by a Professional Engineer licensed in the Jurisdiction of the installation and submitted by the Contractor:
  - a. Tank orientation and elevation views.
  - b. Tank penetrations and points of interface with other contractors.
  - c. Tank, tank foundation and anchorage structural design calculations.
  - d. Tank design calculations including, but not limited to:
    - 1) Tank sizing.
    - 2) Internal flow diffuser sizing calculations.
    - 3) Pressure drop calculations.
    - 4) Heat gain calculations.
    - 5) Foundation drawings.
    - 6) Product data to be submitted by the Contractor:
      - a) Coating data sheets and color sample.
      - b) Insulation details, data sheets and color sample.
      - c) Welder's certifications in accordance with AWWA D100.
    - 7) "Operation and Maintenance Manual": As a minimum, the manual shall include the following:
      - a) Thermodynamic description of each operating mode.
      - b) Safety precautions and instructions.
      - c) Detailed performance test procedure.
      - d) Recommended spare parts list.
      - e) Recommended maintenance practices and schedules for the tank foundation, structure, appurtenances, insulation, internal distribution systems, and special systems supplied by the Contractor (such as cathodic protection, instrumentation, etc.).
      - f) Local contact for the Contractor and for other manufacturers and suppliers of major components, as appropriate.

3. LEED Submittals: Submit in accordance with Section 01 81 11.01.
  - a. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
  - b. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

D. Guarantees and Warranties

1. Contractor shall guarantee the thermal performance of the TES Tank System.
2. Contractor shall provide a one year warranty for materials and workmanship of the TES Tank System.
3. All guarantees obtained by Contractor from manufacturers or installers of paint, equipment or accessories not manufactured by Contractor shall be obtained for the benefit of the Owner.

**PART 2 - PRODUCTS**

**2.1 FUNCTIONAL**

- A. Contractor shall provide a TES Tank System complete with all internal flow diffusers as described herein to store thermally stratified water (or aqueous fluid).
- B. The TES Tank System shall be integrated with the existing chilled water supply system. The TES Tank System shall store chilled water (or aqueous fluid) produced during "off-peak" periods to meet "on-peak" or emergency thermal loads.
- C. The storage tank shall be an above-ground, vertical, cylindrical, flat bottom tank of all-welded steel construction. The tank shall have a column-supported, fixed roof.

**2.2 SYSTEM PERFORMANCE**

- A. RATED THERMAL STORAGE CAPACITY: The TES system shall be capable of storing and delivering a minimum of 5,000 ton-hours of thermal energy as chilled water.
- B. HEAT GAIN: The TES system shall limit the ambient heat gain to less than 2 percent of the rated thermal storage capacity in a 24 hour period. Heat gain will be based on:
  1. The maximum ambient dry bulb temperature for the 0.4 percent cooling design conditions for this locale from the ASHRAE Fundamentals Handbook.



2. Soil temperature assumed to be the average annual dry bulb temperature for this locale from the 2009 ASHRAE Fundamentals Handbook weather station data sheets.
3. Pressure Drop: The total frictional pressure drop from the tank inlet flange to the tank outlet flange at the maximum design flow rate will be a maximum of 3.0 psi.

### 2.3 DESIGN CRITERIA

- A. The tank shall be designed, constructed and tested in accordance with the latest edition of AWWA D100.
  1. Wind velocity: 85 mph.
  2. Seismic design: per AWWA D100, Section 13,  $SUG = II$   
Site Class D  $S_1 = 0.827$   $S_s = 1.959$   $T_L = 12$ .
  3. Amount of freeboard to be provided for a seismic sloshing wave:  $.7 * d$   
( $d$ =sloshing wave height, in feet) ft. (See AWWA D100, para. 13.5.4.4.)
  4. AWWA D100 Section 14 may be employed at the Contractor's discretion.
  5. Roof live load: minimum 15 psf, per AWWA D100.
  6. Corrosion Allowance: None.
  7. The bottom and roof plates shall be assembled using lap joints, welded continuously from the top side only. Shell plates to be 100% full fusion butt-welded joints.
  8. All external attachments to uninsulated roof plates or shell plates shall be seal welded.
  9. Contractor shall provide all necessary internal flow diffusers required to meet the thermal performance specified in Section 2.2 of this specification.
    - a. The internals shall be fully designed, fabricated and installed by Contractor.
    - b. The design shall be based upon proven flow distribution calculations to maintain the operating thermocline between the cold and warm water (or fluid).
    - c. The diffuser shall be inherently robust in order to minimize damage from infrequent, unanticipated water hammer events that could be initiated elsewhere in the hydraulic system apart from the TES Tank.
    - d. Components of the diffuser shall be supported by the tank structural members without the use of pipe hangers.
    - e. The diffusers shall make maximum practical use of corrosion resistant, modular components sized to pass through the shell and roof manholes for easy removal and installation.
    - f. The individual modular diffuser components shall be capable of simple hand tool disassembly and re-assembly to facilitate inspection and painting of the tank bottom and roof support column(s). Such disassembly shall be accomplished without any cutting, burning, welding or gluing.

- g. Adjacent components shall be of an interlocking, self-aligning design.
  - h. The modular, corrosion resistant diffuser design shall be based upon an actual design previously approved by Factory Mutual for use in dual-service, thermal storage and fire protection installations.
- 10. All internal piping, including internal flow distributor and overflow, shall be welded carbon steel.
- 11. The insulation system shall meet or exceed the system performance requirements for heat gain.
- 12. The insulation system shall be designed to withstand a 70 mph wind load.
- 13. The base bid system for the shell and roof insulation shall consist of the following:
  - a. Rigid insulation board of polyisocyanurate or polyurethane, with pre-attached aluminum foil vapor barriers. The board shall have a nominal density of 2 PCF and an aged thermal conductivity value no more than 0.176 BTU-in/hr-ft<sup>2</sup>-°F (i.e., an aged insulating value of at least, R=5.68/inch). Minimum thickness as indicated on Drawings.
  - b. The insulating boards shall be installed as single or multiple layers. The edges of the boards shall be tightly butted against each other. The joints of adjacent layers shall be offset a minimum of 6 in. both vertically and horizontally, during installation. The seams of the boards of all inner layers of multiple layer systems shall be sealed with aluminum foil tape. Alternatively, a bituminous sheet vapor barrier may be applied over the outermost inner layer of boards.
  - c. The outermost layer of the insulation board shall be bonded (laminated) to an aluminum jacket, of 0.024 in. minimum thickness, to provide weather and mechanical protection.
  - d. The metal jacket on both the shell and roof shall have a vertical standing closure seam. These closure seams shall be made vapor tight with a sealant installed in the joint prior to closing the seam. All seams shall be sealed mechanically (by machine) at all accessible locations and hand sealing shall be minimized.
  - e. Horizontal seams between jacket sheets (if required) on the tank shell and the seams at the top and bottom of the shell shall be sealed vapor tight with a non-hardening, permanently flexible sealant or other approved material. Any lapped seams shall be installed in the down weather position to allow water run-off. Horizontal seams (if required) shall be staggered by a minimum of 1'-0 between adjacent vertical panels to avoid a continuous circumferential horizontal seam around the tank.
  - f. Circumferential joints in the roof system (if required) shall consider expansion joints and a down weather lap position. The roof panels can be placed in a radial pattern or a "Chevron" pattern as required to best address the tank diameter.
  - g. The attachment system for the insulation panels shall be a concealed fastener system such as tensioned cables and/or pencil rods. If a cable attachment system is used over the inner layers

- of foam insulation boards, a "softening" material shall be placed under the cables to prevent damage to the insulation.
- h. The exposed insulation jacket shall have an embossed or textured finish. The jacket will be factory coated with a polyester resin. The color shall match the existing, adjacent water storage tank.
  - i. A reinforced corner flashing metal shall be installed at the transition of the roof to shell jackets. This flashing section shall be a rolled section (as opposed to segmental strips). Care shall be taken to minimize penetrations through this corner flashing. Corner flashing shall be provided with a vapor barrier seal and adequately insulated. The vapor seal shall isolate the roof insulation from the shell insulation.
  - j. The insulation system shall include removable insulated covers for:
    - 1) Manholes (shell and roof). Manhole hinges or davits shall be accounted for in the insulated cover design.
    - 2) Anchor bolt chairs (when anchorage is required).
  - k. Contractor's supplied insulation system shall not include insulation of process piping, nozzles, valves and interconnecting piping. Insulation of these items will be the responsibility of others.
  - l. Penetrations through the metal jacket shall be sealed with a non-hardening flexible butyl sealant (or approved equivalent) and penetrations on the roof shall be sealed using a "pitch pot" detail.
  - m. The perimeter area where the tank shell meets the foundation shall be adequately sealed and insulated to minimize condensation. This shall be accomplished by securing insulation and flashing to the tank shell insulation jacket and to a rolled angle located outboard of the tank bottom secured to the concrete foundation with concrete anchors. Flashing shall extend past the edge of the foundation. A vapor tight seal shall be provided from the tank shell, over the bottom extension, across the concrete surface, underneath the perimeter angle and then up to the tank shell insulation.
  - n. An external bottom insulation system shall be provided if necessary to meet the heat gain limits. The system shall be suitably protected from damage during installation and welding of the tank bottom.
  - o. Pumps and panels for TES system shall be outdoor rated NEMA 3R enclosures.

## **2.4 APPURTENANCES**

- A. Tank shall have as a minimum the following fittings and accessories:
  - 1. One (1) 30 inch diameter shell access manhole with hinged door.
  - 2. One (1) 24 inch diameter shell access manhole with hinged door.
  - 3. Two (2) 24 inch diameter rain-proof roof access hatches (one located near the center of the roof).

4. One (1) warm water inlet/outlet nozzle, size as required.
5. One (1) cold water inlet/outlet nozzle, size as required.
6. One (1) overflow nozzle with an internal overflow pipe and an external seize-resistant, anti-thermosiphon device (as approved for Factory Mutual application) located within five (5) feet of grade. Overflow to be sized for the maximum fill flow entering the tank through the fill nozzle.
7. One (1) 6 inch diameter center riser clean out nozzle with blind flange.
8. Accessories as necessary to eliminate vacuum formation and enhance draining in the vertical flow conductor when the tank is placed into or removed from service.
9. One (1) roof vent designed/constructed to prevent entrance of birds or animals. Vent shall have the capacity to pass air so that at the maximum possible rate of water, either entering or leaving the tank, excessive pressure or vacuum will not be developed. The overflow pipe shall not be considered a tank vent.
10. One (1) level instrument nozzle, size as required, shell mounted .
11. One (1) roof nozzle (and stilling well, if required) for temperature sensing elements array.
12. Conduit attachments for temperature sensing and level instrumentation.
13. One (1) straight external ladder with galvanized fall prevention device, intermediate platforms (if required), and two (2) belts as required by OSHA, and a walk-thru at the roof with 10 feet of handrail.
14. Grounding lugs of NFPA 780.
15. Temperature sensing instrumentation will be provided by others. Contractor shall provide the required fittings and mounting brackets.
16. Level instrumentation with high and low level alarm capability will be provided by others. The Contractor shall provide the required fittings and mounting brackets.

## **2.5 COATINGS & FINISHES**

### **A. General**

1. All tank painting shall be in accordance with:
  - a. AWWA D102, the Steel Structures Painting Council Specification, SSPC-PA1, approved paint manufacturer specifications, and this specification.
2. Pre-construction primers may be utilized in the fabrication process to preserve the blast profile and cleanliness. In the field, weld seams and abraded areas shall be cleaned on a spot basis. The remaining sound primer shall be cleaned to remove dirt and other contaminants. After cleaning the specified coating shall be applied in its entirety in the field at the thicknesses specified.
3. No paint shall be applied when the temperature of the surface to be painted is below the minimum temperature specified by the paint

manufacturer, or less than 5 degrees above the dew point temperature. Paint shall not be applied to wet or damp surfaces or when the relative humidity exceeds 85% unless allowed by manufacturer's data sheets. Follow the paint manufacturer's recommendations for the specific paint system used.

4. After erection and before painting, remove slag, weld metal splatter and sharp edges by chipping or grinding. All outside surfaces that have been welded, abraded or otherwise damaged, shall be blast cleaned per SSPC-SP 6. Inside damaged or uncoated surfaces shall be blast cleaned per SSPC-SP 10. Primer shall be applied in the field in accordance with the paint system requirements.
5. All areas blasted in the field shall be coated the same day before any rusting occurs.
6. The dry film thickness values shown below are average values subject to variation in thickness based upon industry practice and manufacturers recommendation. The actual dry film thickness value measured may vary from these average values within the range established by the manufacturer.
7. Stainless Steel, aluminum, galvanized and non-metallic surfaces require no additional coatings. Erection damage to galvanized surfaces, if any, shall be touched up with appropriate material.
8. Color shall match that of adjacent emergency water storage tank.

B. Exterior Coating System

1. The exterior paint system shall conform to Inside Coating System No. 1 as defined in AWWA D102.
2. The tank under bottom shall not be coated.
3. Uninsulated surfaces - AWWA D102 ICS-1-S (color to match insulating jacket).
4. Insulated surfaces - One primer coat (5 mil DFT) from AWWA D102 ICS-1-W.

C. Interior Coating System

1. The Interior Paint System shall conform to Inside Coating System No.1 as defined in AWWA D102.
2. The tank interior shall be left in a broom-clean condition after completion of painting.

## 2.6 CONCRETE FOUNDATION

- A. The foundation, as a minimum, shall be a reinforced concrete ringwall meeting the construction tolerances and design requirements of AWWA D100 and ACI 318. The Contractor shall design the foundation to meet the recommendations of the attached owner supplied geotechnical report for a net allowable bearing value of 2500 PSF for dead plus live Loads with a 1/3 increase for total design loads (including wind or seismic loads. Predicted settlement should be limited to a change in bottom slope of 1:360. The perimeter footing of the tank is be bottomed at least 30 inches below the lowest adjacent exterior soil subgrade or the top of the select fill,

- AB, or lime-treated layer, whichever is deeper. Interior footings are to be at least 24 inches below the lowest adjacent soil subgrade.
- B. If loose or soft soil or non-engineered fill is encountered during footing excavation, the weak soil or fill is to be over-excavated to expose stiff clay or medium dense to dense sand. The excavated material is to be replaced with either structural concrete or sand-cement slurry with a compressive strength of at least 50 psi.
- C. The area around the foundation shall be sloped away from the tank to prevent the accumulation of rainwater.
- D. The vertical surfaces of the ringwall shall be formed ("neat" construction shall not be permitted). The top surface of the ringwall shall be level plus or minus 1/8 inch in any 30 ft. circumference under the shell. The levelness on the circumference shall not vary by more than plus or minus 1/4 inch from an established plane.
- E. Minimum acceptable concrete mix parameters are:
1. Concrete compressive strength,  $f'_c$ : 3000 psi.
  2. Slump: 3 inch.  $\pm$  1 inch.
  3. Air content: 3 percent to 6 percent.
  4. Maximum aggregate size: 1-1/2 inch.
  5. Water-cement ratio of the concrete shall not exceed 0.53 for non air-entrained concrete.
  6. In areas where air-entrainment is required for freeze-thaw protection, the maximum water to cement ratio shall be 0.46.
  7. A sand cushion shall be supplied under the tank. The sand shall pass a 3/4 inch sieve with less than 5 percent retention on a 3/8 inch sieve and less than 10 percent passing a #200 sieve. The sand shall be clean, free from clay balls and lumps of earth and shall be free of corrosive materials, such as salt and sulfur. The maximum chloride content shall be less than 0.03 percent (300 parts per million) and the maximum sulfate content shall be less than 0.10 percent (1000 PPM).
  8. A minimum of 12 inches of non-expansive soil (select fill, Caltrans Class II aggregate base, or lime-treated onsite soil) is to be placed below the sand cushion under the tank. The sand base below the tank is not to be included in the 12 inches of non-expansive soil. If loose or soft soil or non-engineered fill is encountered in a footing excavation, the weak soil or fill is to be over-excavated to expose stiff clay or medium dense to dense sand. The excavated material should be replaced with either structural concrete or sand-cement slurry with a compressive strength of at least 50 psi.
- F. The inside of the concrete ringwall shall be insulated with a minimum 1.5 in. thickness of polystyrene board (or approved equivalent) extending 32 in. below the top of the ringwall (or the maximum depth of the ringwall if less than 32 in.).

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Mill or shop inspection reports shall be supplied per AWWA Section 11 and shall be in accordance with Section 11 of AWWA D100.

#### **3.2 WELDING**

- A. All welders shall be qualified by ASME Section IX for the processes and positions utilized.
- B. Contractor shall employ the services of a welding supervisor independent of the tank erection foreman's jurisdiction.
- C. Welding shall be inspected and tested by radiographic testing consistent with the requirements of Section 11 of AWWA D100. Sectional segments will not be allowed. Additional inspection requirements detailed in Section 14 will be performed if the tank is designed to Section 14.
- D. The edges or surfaces of the pieces to be joined by welding shall be prepared by flame cutting, plasma arc cutting, arc gouging, machining, shearing, grinding or chipping and shall be cleaned of detrimental oil, grease, scale and rust. The edges of the pieces may have a protective coating applied to them which need not be removed before they are welded unless specifically prohibited by the WPS.
- E. Welding procedures and welding operators shall be qualified in accordance with ASME Section IX. All field welding may be done by the shielded metal arc welding process, the gas metal arc welding process, the flux core arc welding process, or the submerged arc welding process. Shop welding may be done by the shielded metal arc process, the submerged arc welding process, the gas metal arc welding process, or the flux core metal arc welding process.
- F. Plates and component members of the tank shall be assembled and welded following erection methods that minimize the amount of distortion due to weld shrinkage. The weld metal shall meet or exceed the minimum requirements for visual inspection in AWWA D100 Section 11.4 and as set forth in the radiographic acceptance standards of AWWA D100 Section 11.6.10. Surfaces to be welded shall be free from loose scale, slag, heavy rust, grease, paint and other foreign material.

#### **3.3 TESTING & WATER TREATMENT**

- A. Hydrostatic Test
  - 1. In accordance with AWWA D100, Contractor shall fill and test the tank after the completion and acceptance of the tank coating. Upon completion of an acceptable test, the test water shall be retained for process use. Cleaning, flushing and water treatment shall be the responsibility of Contractor.
  - 2. Connection and supply of water shall be the responsibility of Contractor. The tank shall be filled to the overflow level in a 48 hour period. Contractor shall supply an inspector for both days of the test. The hydrostatic test inspection shall be a visual leak

inspection made from grade and existing ladders, stairways and platforms.

B. Performance Test

1. The Owner requires a performance test of the TES Tank System to verify its ability to meet the performance requirements of paragraph 2.2 of this specification. The test shall take place within 30 days of substantial completion of the TES Tank System.
2. If the design cooling load is not available at the time of testing, the performance test shall be based on recharging the TES Tank System
3. Supply and operation of all existing chilled water system equipment shall be by the Owner or the Owner's representative and shall be coordinated with the Owner in advance of the test with sufficient time to enable the Owner to make the appropriate arrangements for chilled water availability. Contractor shall provide a qualified engineer to monitor the test. Contractor shall review the test data and issue a written report to the Owner
4. The TES Tank System shall have met the specified performance requirements if after the flow of one complete tank volume, the stored thermal capacity is equal to or greater than the design value stipulated in this specification (within the accuracy of the flow and temperature instrumentation).
5. The Performance Test shall be conducted in accordance with Section 23 24 01, THERMAL ENERGY STORAGE TANK SYSTEM PERFORMANCE TESTING. In the event of an unsuccessful Performance Test, the Contractor shall make any required modifications at their own expense and the Performance Test shall be re-run at no further expense to Owner.

**3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

**3.5 CONSTRUCTION WASTE MANAGEMENT**

- A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

- - - E N D - - -



**SECTION 25 60 00**

**CHP PLANT CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide all hardware, software, engineering, fabrication, programming, delivery, installation, inspection, testing, start-up, commissioning, and training as specified herein for a new Combined Heat and Power (CHP) Plant automation and control system for the new Cogeneration (co-gen) System furnished as part of the Loop Road and Site Utilities project at the VA Medical Center in Palo Alto. This section includes specifications for overall control capabilities to be provided by the CHP plant controls system, as well as specific control functions and hardware not covered elsewhere in the bid documents. Parts of the CHP Plant Control System, such as PLC control panels, are specified elsewhere in the bid documents.
- B. The CHP Plant control system shall be able to control the plant as a stand-alone system, however, for remote reporting, select data shall be available to the site's FMCS system (Siemens Apogee and other legacy Siemens systems). Coordinate with Siemens and provide all hardware, software and programming required to allow the FMCS interface for seamless integration. The System Integrator shall be responsible for selecting the points whose data needs to be communicated to the FMCS.
- C. The control system shall consist of SCADA/HMI software on an industrial application server for integration of multiple PLC's for automation, monitoring and control of the cogeneration plant. A System Integrator shall be responsible for tying the subsystems together, passing data to and from the needed systems, planning and coordinating Ethernet, fiber and hardwired connections between devices and in programming the system including HMI interface and graphics/point mapping etc. for full functionality of the CHP Control System. The control system shall be part of the CHP 'package', provided as a complete system to insure compatibility and performance. Refer to Section 263214- Combustion Turbine Generator for packaging requirements.

**1.2 WORK INCLUDED**

- A. Provide a CHP Plant PLC control system hardware for system integration as follows:
  - 1. Central server/workstation to support all PLC's and to host integration and control software, and to provide central management and logging of alarms and trend data. Server shall be equipped with the following minimum components and capacity. System Integrator is responsible for selecting system components over and above the minimum capabilities listed as required to achieve the needed functionality for the CHP Plant control system.
    - a. Quad-core 2.66 GHz processor with 6 MB Cache and 1333 MHz FSB.

- b. 16 GB 667 MHz RAM.
    - c. Redundant Power supply.
    - d. Two 160 GB, 7,200 PRM Serial ATA 3 Gbps hard drive in Raid (mirror) configuration.
    - e. Eight high speed USB ports.
    - f. Serial and parallel ports.
    - g. DVD-ROM and DVD-RW dual drives.
    - h. 10/100/1000Base-T Ethernet card.
    - i. USB optical mouse.
    - j. USB keyboard, standard 101 keys.
    - k. Provide (4) 24 inch LCD color monitor, 1920 x 1200 with simultaneous display of data, graphics, etc.
    - l. All required operating system software, automation/application software, graphical user interface software, web browser and other necessary software including virus protection software (5 year license).
    - m. Alarm printer and conventional wide format color inkjet printer (11 x 17 capable).
  - 2. One (1) PLC Panel for CHP Plant balance of plant instrumentation and control.
  - 3. Two (2) LCD alarm annunciator panels to be positioned in the plant at locations to be determined in the field.
  - 4. Required software, hardware, drivers, and configuration to map data for monitoring and remote interface purposes by the Facility Monitoring and Control System (FMCS) through BACnet over TCP/IP Protocol.
  - 5. Required software, hardware, drivers, and configuration to map data from all power monitoring system and other vendor packaged controls through Modbus protocol to the CHP Plant PLC control system.
  - 6. Category 6 Ethernet cables and conduits from Ethernet switches to devices such as PLC processors, FMCS/BAS workstations, servers, and other communication hardware as required.
  - 7. Coaxial cables and conduits for the control system network if required.
  - 8. Twisted pair and/or Ethernet cables to connect all electrical monitoring equipment, and other vendor packaged equipment as required on the RS485 Modbus RTU communication networks.
- B. Provide meters (as specified in Section 230923-Facility Monitoring and Control System and Division 26) to measure the cogeneration system's energy performance, including:
- 1. Generator electrical output.
  - 2. Electrical input to gas compressor and other cogeneration auxiliaries.
  - 3. Net electrical output.
  - 4. Natural gas flow to combustion turbine.

5. Natural gas flow to duct burner on HRSG.
  6. Steam pressure.
  7. Steam flow.
  8. Feedwater temperature.
  9. Feedwater flow.
- C. Provide all engineering, programming, design installation, configuration, startup, commissioning, training, troubleshooting, and support services specified herein to enable a fully functional and reliable control system that includes, but not limited to, the PLC, FMCS Interface, SCADA/HMI package, balance of plant field instrumentation, and vendor packaged CHP equipment controls.
- D. SCADA/HMI and PLC programming software licenses and control system ladder logic programming to include all required sequences
- E. All field instrument hardware and installation as specified on P & ID's or required by CHP equipment vendors as determined by Systems Integrator.
- F. Technical and supervision services of the CHP control system during installation, field testing, system start-up and commissioning.
- G. Coordination with vendor to interface with vendor supplied PLC control systems and technical services to start-up and commission the PLC control systems.
- H. Operator training of the entire Control System including the interface with vendor supplied PLC control systems.

### **1.3 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.
- D. Section 01 81 11.01, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.
- E. Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.
- F. Section 23 12 34, FUEL GAS COMPRESSOR.
- G. Section 23 52 35, HEAT RECOVERY STEAM GENERATOR.
- H. Division 26 for Electrical Specifications.
- I. Section 23 09 23, FACILITY MONITORING AND CONTROL SYSTEM.

J. Section 26 57 00 CONTINUOUS EMISSIONS MONITORING SYSTEM.

#### **1.4 UTILITIES AVAILABLE**

- A. Electricity: 120 Volt, single phase, 60 hertz; 480 Volt, three phase, 60 hertz.
- B. Compressed Air: 100 psig, dry.
- C. Campus Ethernet.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Association and International Society for Automation (ANSI/ISA):
  - 1. ANSI/ISA 77.41.01-2010 - Fossil Fuel Power Plant Boiler Combustion Controls
- C. American National Standards Association and American Society of Heating Refrigeration and Air Conditioning Engineers (ANSI/ASHRAE):
  - 1. ANSI/ASHRAE 135-2010 BACnet™ - A Data Communication Protocol for Building Automation and Control Networks
- D. Underwriter Laboratories (UL):
  - 1. UL 508-99 Industrial Control Equipment.
  - 2. UL 508A-01 Industrial Control Panels.
  - 3. UL 916-10 Energy Management Equipment
- E. National Fire Protection Association (NFPA):
  - 1. NFPA 85-07 - Boiler and Combustion Systems Hazard Code.
  - 2. NFPA 70-08 - National Electrical Code.
  - 3. NFPA 79-07 - Electrical Standard for Industrial Machinery.

#### **1.6 ABBREVIATIONS AND DEFINITIONS**

- A. In addition to the requirements of Section 014200 - Reference Standards, the following definitions and abbreviations, specific to the products and services specified herein, shall apply.
  - 1. Abbreviations
    - a. BMS: Burner Management Systems.
    - b. BOP: Balance of Plant.
    - c. CEMS: Continuous Emissions Monitoring System.
    - d. CHP: Combined Heat and Power.
    - e. CSDS: Computer System Design Specification.

- f. DA: Deaerator.
- g. DDC: Direct Digital Control.
- h. DDS: Detail Design Specification.
- i. FMCS: Facility Monitoring and Control System.
- j. HDS: Hardware Design Specification.
- k. HFAT: Hardware Factory Acceptance Test.
- l. HMI: Human Machine Interface.
- m. I/O: Inputs and Outputs.
- n. LAN: Local Area Network.
- o. ModBus: Serial communications protocol for use with PLC's and other industrial electronic devices.
- p. OIT: Operator Interface Terminal.
- q. OPC - OLE: (Object Link Embedded) for Process Controls used as standard set of objects, interfaces and methods for industrial manufacturing and automation interoperability.
- r. PID: Proportional, Integral, Derivative control algorithm.
- s. P&ID: Process & Instrumentation Diagram.
- t. PC: Personal Computer.
- u. PLC: Programmable Logic Controller.
- v. PM: Power Monitor.
- w. RIO: Remote Inputs and Outputs
- x. SAT: Site Acceptance Test.
- y. SFAT: Software Factory Acceptance Test.
- z. System Integrator - the party responsible for designing, construction, configuring, programming, testing, delivery, start-up, and commission of the CHP Plant PLC Control System.
- aa. SQL: Structured Query Language for relational database management systems.
- bb. TBD: To Be Determined.
- cc. TCP/IP: Transmission Control Protocol/Internet Protocol.
- dd. UPS: Uninterruptible Power Supply.
- ee. VFD: Variable Frequency Drive.

#### **1.7 QUALITY ASSURANCE**

- A. All products and services shall be provided by a qualified System Integrator regularly engaged in system development and implementation using PLCs, industrial HMI interface and historian data acquisition software. Equipment and services provided by integrator shall have experience with the software platform and PLC devices utilized as part of the system. Integrator shall be part of CHP Package furnished by Contractor as described in other Sections.
- B. System integrator shall provide for a complete and functional system and shall be responsible for all design, installation, programming testing, commissioning utilizing either in-house capabilities and or subcontracting to other entities. Regardless, Integrator shall utilize Factory trained

and manufacturer certified technicians to provide installation, instruction, routine maintenance, and emergency service.

- C. Integrator shall have or utilize contractors who have complete engineering, sales, installation, and service operations for a period of not less than five (5) years prior to the bid date of this project. The Integrator shall have:
  - 1. Three (3) customer references each having a CHP Control System installed and operational for the past 5 years.
  - 2. Reference information must include the following:
    - a. Customer name.
    - b. Address.
    - c. Contact name.
    - d. Contact phone number.
- D. Integrator shall have a service and support facility within 120 miles of the project site with the capability of responding to a request for service within 24 hours. Service and support must be available seven (7) days a week. This facility shall have on-hand sufficient technical and service staff and spare parts necessary to respond effectively.
- E. Integrator shall present reasonable assurances that this equipment will not be obsolete in the near future. In the belief that portions of this equipment will eventually be withdrawn from sale, a firm commitment by the supplier for a minimum of 10 years spare parts support from the purchase order date shall be made. Each bidder shall present their design concept of adding new technology in the future (keeping this system continuously current).
- F. Prior to acceptance, all software and its programming necessary for the operation of the system shall be provided. All software shall be licensed and delivered to the Resident Engineer.
- G. Integrator shall have single source responsibility for the complete system's installation and satisfactory operation including setting up and entering the system's initial operating programs and database, debugging and tuning of the operating programs, and calibration of the system and its components.
- H. The VA reserves the right to reject the Contractor's selected System integrator based on a lack of demonstrated experience in integrating utility plant facilities similar to those specified herein.

#### **1.8 WARRANTY**

- A. The warranty shall include the following provisions:
  - 1. The Contractor shall warrant labor and parts for the CHP Control System free from defects for a period of 48 months from the date the system is completely installed, fully operational, and accepted by VA. The Resident Engineer representing the VA shall verify in writing that the CHP Control System has been tested and accepted in accordance with

this specification. The date of acceptance shall begin the warranty period.

2. The warrant shall include, but not be limited to, the following: Labor, travel, living expenses, parts replacement, system maintenance and testing, and software/hardware updates and revisions.
  3. Work shall have a single warranty date, even if the Owner receives beneficial use due to early startup.
  4. The Contractor shall provide updates to project-specific software and firmware that resolve Contractor or Owner identified software deficiencies at no charge during the warranty period.
  5. In the event that the Contractor service call work causes damage to additional equipment, the Contractor shall be liable for labor and material to restore the system to full operation.
- B. During the warranty period, the Contractor shall update the software free of charge as manufacturer's software is improved.

#### **1.9 SUBMITTAL REQUIREMENTS**

- A. Submit in accordance with Section "Shop Drawings, Product Data, and Samples".
- B. Contractor shall submit for approval detailed qualifications for the System Integrator prior to authorizing the System Integrator to Proceed with the Work.
- C. System Integrator shall provide the following specific documents and materials for review:
1. PLC Control System Functional Description.
  2. Detail Design Specification (DDS) - The DDS shall define all PLC node programming and sequences of operation. In addition the DDS shall define all of the HMI programming requirements including alarm summaries, historical trend summaries, graphic screen listings and all information required for the proper interface requirements to the FMCS network.
  3. Hardware Design Specification (HDS) - The HDS shall define all of the new field instruments & controls that will make up the CHP Control System. This includes field sensors, field controllers, panels for local/remote control and indication, operator interface terminals, printers, servers, power supplies, I/O modules, third party interfaces, field wiring terminations, power distribution wiring, and operating and application software packages. With the HDS, shall be submitted a database list showing point tag, point description, I/O type, processor address, module address, termination unit and channel number, signal range; power source and remarks.
  4. Control System Architecture -The Control System Architecture shall depict all PLC nodes, remote I/O nodes and all interfaces to the FMCS including all communications risers and protocols. Refer to Section 23 09 23 FACILITY MONITORING AND CONTROL SYSTEM for further requirements for system architecture design.

5. Detailed Sequence of Operations.
  6. Logic Diagrams.
  7. PLC control panel full-scale detailed production drawings - Panel production drawings shall be developed for, but not limited to, each PLC node, remote I/O node, hub panels, fiber panels, and equipment interface panels as required.
  8. PLC Panel Riser Diagrams - Single line riser diagrams for each PLC panel and remote I/O node. These single line risers shall detail wire type and conductor quantities required for each field device and I/O point.
  9. PLC control panel wiring and interconnection diagrams - Detailing the internal panel wiring needed for panel fabrication and the individual point-to-point loop sheets for each physical I/O point connected to the PLC.
  10. Backup documentation for all PLC programming logic/codes, graphic screens and tags in the form of hard copies printouts and electronic files.
  11. Complete sets of instruction manuals of all PLC hardware and software components.
  12. Hardware Factory Acceptance Test (HFAT) - This document shall detail the test procedures to be performed on each PLC control panel and its components furnished by the Systems Integrator.
  13. Software Factory Acceptance Test (SFAT) - This document shall detail the test procedures to be performed for each CHP Plant program component.
  14. Site Acceptance Test (SAT) - This document shall detail the on-site tests to be performed by the Systems Integrator to verify the proper functionality of PLC components and subsystems.
  15. System Operator's Training Manual - This document shall detail system operation, PLC programming standards, trending, maintenance and troubleshooting with screenshots.
- D. Due to the complex nature of the equipment and services specified herein, the submittal process shall require two milestone progress submissions, one final submission and one as-built submission as follows.
1. The first progress submission shall include the following minimum documentation:
    - a. Preliminary Control System Architecture Diagram.
    - b. Draft Computer System Design Specification including a preliminary list of software packages.
    - c. Draft Functional Description.
    - d. Draft Detail Design Specification.
    - e. Sample HMI screen captures.
    - f. Draft Hardware Design Specification including a preliminary hardware Bill of Materials.



2. The second progress submission shall include the following minimum Documentation:
  - a. All of the documents submitted at the 30 percent submission at a substantially complete level of development.
  - b. Logic Diagrams.
  - c. I/O list.
  - d. CHP Control Panel and Alarm Annunciation Panels.
  - e. PLC Riser Diagrams.
  - f. Panel Termination/Wiring Diagrams.
  - g. Loop Diagrams.
  - h. Complete set of actual OIT HMI screen captures.
  - i. Factory Acceptance Test Protocol: HFAT, SFAT and SAT.
  - j. Preliminary Operator Training Manual.
3. The final submission shall include all documents previously outlined in the first and second progress submissions in their final form. Documents shall fully address the scope of the project and reflect resolution of all comments.
4. The As-Built documentation shall reflect any changes made during the construction, startup, commissioning, training, and acceptance testing stages of the project.
5. In addition to the milestone submissions, the Owner reserves the right to request one additional on board review for which a complete set of progress documentation at the time of the request shall be submitted.
6. All submitted materials must be made available, as a minimum, in a compatible native electronic format such as AutoCAD drawings, Microsoft Word, Microsoft Excel. This format will allow future updates of these materials. For vendor information files, such as commercial equipment document may be Adobe PDF format as there would be future need to edit these files. Five complete sets of hard copy submittals shall be provided in addition to the electronic files.

E. LEED Submittals: Submit in accordance with Section 01 81 11.01.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

#### **1.10 SAFETY**

- A. In order to comply with OSHA requirements for lockout and tagout, lockable devices shall be provided to isolate and safely release electrical, pneumatic and other potential sources of energy. These provisions shall be included in the design, should this requirement extend to the mechanical or electrical design and construction firms, the requirement shall be

identified to the system designer and/or the Owner in writing as a Request for Information or other project agreed-to mechanism.

- B. The Manufacturer shall warrant that all equipment complies with the appropriate standards for controls and design as outlined by current OSHA regulations.

#### **1.11 COMMISSIONING AND STARTUP**

- A. System Integrator shall support the commissioning activities starting with installation support during construction, wiring checkout, initial startup, commissioning, trouble shooting and acceptance testing. This support level shall be included in the proposal as outlined below.

Specific Startup and Commissioning Services:

1. Participate in a minimum of one project kick-off meeting at location to be determined by the Owner. Assume that this will take place on-site.
  2. Conduct a minimum of two preliminary job-site walk-down to familiarize the Commissioning Team with the equipment to be interfaced with the CHP Control System. Preferably, coordinate site visits to coincide with participation of CHP, HRSG, CEMS and gas compressor manufacturer's technicians to have a coordinated discussion.
  3. Participate in a minimum of twelve construction and commissioning progress review meetings at a location to be determined by the Owner. Assume that these meetings will take place on-site.
  4. Develop and update project schedule for commissioning activities for review by the Commissioning Agent.
  5. Coordinate CHP Control System communication requirements and issues with equipment manufacturers and manufacturer's startup technicians.
  6. Install, test and debug all software required for CHP Control System development, operation and troubleshooting.
  7. Provide a manufacturers' field technician to do start-up, testing, and validation of field accuracy of any metering systems provided.
  8. For vortex meters, include vibration level testing and certification that the meter readings are not influenced by outside sources of vibration as measured on-site.
  9. Provide five (5) dedicated workdays for installation assistance and verification services.
  10. Provide a minimum of twenty (10) workdays of start-up and commissioning services.
- B. The number of working days indicated is for installation support, startup and commissioning services. Any time expended by the System Integrator to perform responsibilities associated with manufacture, programming, delivery, or warranty of defective work shall not be counted against the working days indicated.

## **1.12 OPERATOR TRAINING**

- A. The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the system as specified. The training shall be oriented to the system being installed under this contract. Training manuals shall be provided for each trainee with two additional copies provided for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson.
1. The Contractor is responsible for furnishing all audiovisual equipment and all other training materials and supplies. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Owner in addition to the printed training manuals and on the same media as that used during the training sessions, in the same quantity as specified for training manuals.
  2. A training day is defined as eight hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the normal first shift in effect at the training facility. Travel costs to/from VA Medical Center, Palo Alto, CA. shall be included.
  3. For guidance in planning the required instruction, the Contractor should assume that attendees shall have a high school education or equivalent, are familiar with mechanical and electrical systems, and have the knowledge to operate a workstation to use Windows.
  4. All training shall be completed within 90 days of owner acceptance and schedule timing shall be determined by owner.
- B. Operator Training: Training course shall be taught four times at a location convenient to the VA in a facility suitable for and equipped for the level of training provided:
1. Training course shall each consist of four periods of two consecutive training days each. Contractor shall plan for and train an attendance of ten (10) personnel for each training day.
- C. Maintenance Personnel Training: The maintenance course shall be taught twice at the project site after completion of the operator training, each for a period of two training days. A maximum of ten (5) personnel shall attend the course each course. The maintenance course shall include but not be limited to:
1. Physical layout of each piece of hardware.
  2. Troubleshooting and diagnostics procedure.
  3. Repair instructions.
  4. Preventive maintenance procedures and schedules.
  5. Calibration procedures.
  6. Restart of each system after a power failure.

- D. Training courses shall enable trainees to accomplish the following objectives:
1. Understand control system architecture and configuration.
  2. Understand PLC system components.
  3. Understand system operation, including PLC system control and optimizing routines (algorithms).
  4. Operate PLC Portable Operator's Terminal, and all controls that are part of the CHP Control System
  5. Understand system drawings and Operation and Maintenance manual.
  6. Create, delete, and modify alarms, including configuring alarm reactions.
  7. Configure and start, stop, download, view and interpret trends.
  8. Maintenance software and prepare backups.
  9. Understand password security procedures.
  10. Understand steps and requirements for programming of the CHP Control System.
  11. Understand the functionality of each system component.
  12. Adjustment, maintenance and replacement of the system components.
  13. Features of the graphic representation of the process equipment.
  14. Features of the graphic representation of trends, reports, and data logs.
  15. Interpretation of diagnostic displays and data.
  16. Data archiving procedures from the FMCS.
  17. Service and maintenance schedules.
  18. Upon completion of the training course, each student, using appropriate documentation, should be able to perform elementary operations and describe the general hardware architecture and functionality of each system. Each student shall be tested on this ability and shall receive either a report on areas where they are deficient or a certificate that they have attained competency in the areas required by this specification.
- E. Video Taping: The Contractor shall videotape each lesson and turn the volume of tapes over to the VA after completion of each Operator Training Phase.
- F. The training shall include all necessary supplies, training materials and handouts.

#### **1.13 SPARE PARTS**

- A. Provide all on-hand (construction) spare parts with a label with a reference number for each item. All parts will be identified with this reference number which will provide the location/system, source of each part, cost, manufacturer, model number, storage requirements, lifetime and any other

pertinent data needed to maintain or use the part. The Spare Parts inventory spreadsheet shall be in Microsoft Excel and delivered in the native format to the Project.

- B. Provide any additional "critical" spare parts for initial startup that are recommended to have on-hand to minimize unplanned control equipment downtime, and/or construction delays. Critical items are those that will result in the system being unavailable to perform its function, those items that provide interface with the FMCS, or those items that affect safety. These parts will be included as "on-hand" spares with the same requirements as item A above.
- C. A list of the balance of Spare Parts list shall be provided no less than one month prior to equipment shipment to job site and shall recommend spare parts expected for replacement during the first 4 years of operation. This can be use the Spare Parts inventory spreadsheet as long as the item is identified as "recommended".

#### **1.14 SPECIAL TOOLS**

- A. Provide two (2) sets of new special tools normally provided for the equipment provided, for initial installation and maintenance, including cable testers & process calibrator simulators.

### **PART 2 - PRODUCTS**

#### **2.1 SYSTEM DESCRIPTION**

- A. General
  - 1. The CHP Control System shall be designed and programmed to serve as the primary SCADA/HMI and data concentrator to interface all vendor packaged equipment controls and other controls required to control and monitor the CHP system as well as transmit up to 500 communicated points between the CHP Control System and the FMCS via Ethernet using BacNet or Modbus TCP/IP protocols.
  - 2. CHP control system shall be implemented for safe and reliable supervisory control, monitoring, alarming, and optimization of the CHP plant operations under all operating conditions. The CHP control system shall consists of a network of PLC, I/O panels, alarm displays, and a Supervisory Control and Data Acquisition (SCADA) system. Included in the SCADA are Human Machine Interface (HMI) servers, operator stations, engineer stations, historian servers, displays, communication interface, and alarm/graphic printer.
  - 3. The CHP Control System shall be capable of providing control strategies for the system based on information from any or all connected inputs. Controller devices shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN.
  - 4. The majority of the new CHP equipment packages shall have their own internal controls provided with the equipment. Individual control subsystems shall be fully capable of independent operation and shall

have communication links and/or hard-wired connections to the CHP Control System.

- B. Controls included in this Section will interface to control panels on the equipment specified in other Sections, such as CTG and HRSG, through ModBus, BacNet and or gateways provided by the control panel and/or equipment manufacturers. The controls in this section will be wired to sensors and control inputs on equipment specified in other sections only where that equipment does not have a PLC or control panel with a gateway that might be used, and where the wiring to the sensor or control input will not void a warranty, violate a code or regulatory requirement, create a hazard, or interfere with the functioning of the equipment.
1. The following new equipment packages shall be interfaced with the CHP Control System via Ethernet/IP and/or Modbus communication links. The need for the use of standard connections for this purpose or isolation as discussed above shall be adhered to:
    - a. Combustion Turbine Generator (CTG) PLC systems, Kw Import/Export PLC system and load shed PLC system via an independent Ethernet / IP network using industry standard protocols such as Modbus, Profibus, BacNet etc.
    - b. HRSG Combustion Control PLC's and Burner Management System PLC's.
    - c. Gas compressor PLC systems.
    - d. Air compressor PLC system.
    - e. Power Monitoring system.
    - f. One (1) CEMS analysis console PLC system.
    - g. Two (2) LCD alarm annunciator panels.
    - h. Two (2) anhydrous ammonia SCR PLC systems.
    - i. Facility Monitoring and Control System (FMCS).
    - j. Building Automation System (BAS).
  2. The following new equipment packages shall be interfaced with hardwired points for control and monitoring:
    - a. Gas Turbine Generator turbine control panel.
    - b. HRSG combination combustion control and burner management system panel.
    - c. HRSG continuous blowdown controllers.
    - d. New feedpump VFDs.
  3. The following control parameters are anticipated to be directly controlled or monitored by the CHP Control System subject to the limitations set above and subject to final determination by System Integrator:
    - a. Steam pressure off HRSG.
    - b. Remote duct burner enable/disable operation.
    - c. New feed pump control (remote in existing boiler plant).
    - d. HRSG blowdown conductivity levels (monitoring only).
    - e. Compressed air system control and monitoring.
    - f. LEL alarm and monitoring.
    - g. Ammonia emergency shutdown and header isolation valve control.

- h. Ammonia supply bottles pressure monitoring.
- i. High pressure natural gas emergency shutdown valve control.
- j. Combustion turbine fluid drain tank monitoring.

## 2.2     **HARDWARE REQUIREMENTS**

- A. General Summary. Plant operators and supervisors shall be able to easily determine operations status and perform all major control functions using the HMI workstation(s). The CHP Control System shall consist of, but not be limited to, balance of plant PLC control panel for the CHP plant, HMI Workstation, and remote alarm annunciator panels all communicating via the CHP plant Ethernet communication network.
- B. CHP PLC Panel Hardware Components:
  - 1. Provide wall mounted, floor mounted, or free standing, UL rated, NEMA 4, painted steel PLC panel to be located in the new Cogen Plant. All components penetrating this panel must be selected and installed so that the panel maintains is NEMA 4 rating.
  - 2. Access to panel internals shall be from the front side of the panel only.
  - 3. The PLC panels shall, as a minimum, include the following components:
    - a. Redundant PLC processors configured in hot backup mode with redundant Ethernet connections to support a bumpless switchover in case of controller failure.
    - b. PLC processor with compact flash memory.
    - c. Redundant power supplies for PLC processors. One set of two redundant power supplies for each processor.
    - d. Computer and display terminal with the maximum size color LCD screen compatible with mounting in the panel. A complete system shall be provided including a slideout keyboard and panel mounted keypad, touchscreen and communication capabilities.
    - e. Separate I/O Chassis with dedicated power supply, redundant communication capabilities.
    - f. Redundant Communication between processors, OIT display and remote I/O racks. Taps shall be mounted on DIN rail.
    - g. One Industrial Ethernet Switch with twenty-four RJ-45 ports and two Fiber Optics ports..
    - h. 24VDC power supply for instrument power, and adjustable output voltage of 24 to 28VDC. Power supply should be sized for 150% of the estimated load.
    - i. Two (2) hardwired emergency stop pushbuttons mounted in the front of the CHP Plant PLC panel. Buttons shall be normally closed red mushroom head push-pull type with protective guard to prevent accidental tripping. Provide buttons for Turbine Generator HRSG and Master Fuel Trip / Ammonia Evacuation. E-Stop circuits shall be clearly labeled. E-Stop wire shall be clearly labeled and separated from panel wiring to prevent accidental tripping.
    - j. Digital output cards shall be dry contact type. For output loads above the contact rating of the card, interposing relays should be used.

- k. Inputs and outputs shall be wired to a terminal strip and provided with separate return wires. Field wiring shall terminate on one side and the wiring to the I/O module shall terminate on the other side. Wire spare I/O points from the I/O module to the terminal block.
  - l. Each analog input shall be fused individually.
  - m. I/O cable shields shall be gathered at the field terminal blocks and connected to an isolated shield common, then to a ground bus.
  - n. Main Fuse for incoming 120VAC control panel power.
  - o. 120VAC Circuit Breakers to distribute power within the panel. Individual distribution breaker shall be furnished for the following loads: PLC processor and remote I/O rack power supplies (one per power supply), 24VDC instrument power supplies (one per power supply), digital inputs (one breaker to feed all inputs), digital outputs (one breaker to feed all outputs), 120VAC instruments (one breaker to feed all instruments), and the convenience receptacle.
  - p. 120VAC Fuses, fed by the above mentioned breakers, protecting each digital input and output card; and each 120VAC field instruments.
  - q. Duplex 120 VAC receptacles, protected by a five Amp circuit breaker and labeled "FOR SERVICE LAPTOP ONLY".
  - r. Fluorescent lighting package with door activated switch.
  - s. Door mounted folding metal shelf for service laptop.
  - t. Closed loop cooling equipment to eliminate the heat build-up within the consoles enclosure due to the enclosed equipment or ambient conditions.
  - u. Internal cabling management system for the routing and protection of wiring.
  - v. All terminal block shall be finger safe or guarded to prevent accidental shock hazard.
  - w. Engraved phenolic equipment labels for devices mounted inside and on the surface of panels. Label contents and colors to shall be approved by Owner prior to application.
4. Plant Annunciation Features (Alarms, Strobes, horns). The following shall be provided:
- a. Two horns max with volume control.
  - b. Multiple (up to ~2) strobes 9red flashing)alarms.
  - c. Alarms only activate horns and strobes for hazardous conditions that could affect personnel working in the Central utility Plant, for events such as a Turbine shutdown, for example, no horn or strobe will be generated. The Control Room operator will coordinate any actions necessary for non-hazardous conditions (alarms on FMCS).
  - d. Alarm for the Central Utility Plant can come from the PLC for these hazards so the logic and horn/strobe controls can come from the PLC I/O. Access for silencing the horn has to come from the Control Room Operator with a "Disable" shutoff key switch at the PLC panel if the FMCS is off-line so that there is no way to silence the horn or strobe. This switch could be just a "normal or



Bypass" which in normal the Control Room FMCS can only silence/acknowledge the alarms in "Bypass" a pushbutton on the PLC panel is allowed to acknowledge the alarm (silences the audible, the strobe will continue until the alarm is clear). A feature shall be provided to disable alarms (audible and strobe) for long-term failures that cause an alarm. The FMCS disable function shall extend to the PLC logic so that a lock-in alarm doesn't continue to cycle the alarm.

5. The following minimum spare capacity shall be available in the CHP Plant PLC panel to allow for future plant additions:
  - a. Thirty percent spare PLC processor memory.
  - b. Twenty percent spare circuit breakers.
  - c. Twenty percent spare AC fuse blocks.
  - d. Twenty percent spare DC fuse blocks.
  - e. Twenty percent spare logic block capacity in the most heavily used control processors.
  - f. Twenty percent spare I/O points.
  - g. Twenty percents spare slots in I/O chassis.
  - h. Space for forty percent spare terminal blocks.
  - i. Space for terminal blocks to accommodate future expansion in unused I/O chassis slots.
- C. Portable Maintenance Notebook PC. System Integrator is responsible for selecting system components over and above the minimum capabilities listed as required to adhere the needed functionality for the CHP Plant control system. Provide the following minimum configuration for the portable notebook PC:
  - a. Intel Core 2 Duo, 3MB Cache, 2.1GHz, 800MHz FSB.
  - b. 4 GB Dual Channel DDR2 SDRAM.
  - c. CD/DVD burner (DVD+/-RW) Drive.
  - d. Windows XP operating system.
  - e. One (1) serial, and two (2) USB 2.0 ports.
  - f. Integrated wireless networking capability.
  - g. 10/100 base-T network interface card.
- D. Alarm Annunciation Panel Requirements
  1. Provide two (2) new LCD alarm annunciator panels to be located on the plant operating floor of the new Cogen Plant to notify operators of alarm conditions. The alarm annunciator panel locations shall be coordinated with VA.
  2. Each panel shall be housed in a wall mounted, UL rated, NEMA 4 painted steel panel.
  3. Alarm tags and messages shall be submitted as part of the system document to the Owner for review and approval prior to the programming of the alarm annunciator modules.
- E. CHP Plant PLC UPS System Requirements. Contractor shall provide a UPS power supply for power to new equipment. Contractor shall provide all

cables, conduit, circuit-breakers, and associated equipment needed for providing power to all equipment installed under this contract and shall be responsible for all installation.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. General**

1. Install systems and materials in accordance with manufacturer's installation instructions. Mount controllers at the convenient locations and heights unless otherwise specified. If access to critical components and or code required disconnects is higher than allowed for by code or OSHA, Contractor shall provide suitable code compliant fixed access and clearances.
2. Drawings of the CHP Control System network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the VA shall be furnished and installed without additional cost.
3. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical and parallel to walls) wherever possible.
4. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
5. Install all equipment in readily accessible location as defined by chapter 1 article 100 part A of the NEC. Control panels shall be attached to structural walls unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
6. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
7. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

##### **B. Wiring**

1. All control and interlock wiring shall comply with the national local electrical codes and Division 26 of these specifications. All wiring shall be in conduit.
2. Do not install Class 2 wiring in same conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
3. All wire-to-device connections shall be made at terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

4. Maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, step down transformers shall be provided.
5. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
6. Size of conduit and size and type of wire shall be the design responsibility of the controls Contractor, in keeping with the manufacturer's recommendation and NEC.
7. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the jobsite.
8. Liquid-tight, flexible metal conduits shall not exceed 3 feet in length and shall be supported at each end. Flexible metal conduits shall not be used.

### **3.2 SEQUENCE OF OPERATIONS**

- A. The CHP Control System shall allow for fully automatic operation of all CHP plant equipment and control devices. The following information provides a general functional description of system control and monitoring requirements; this shall be reviewed with and supplemented by the various equipment manufacturers so that the proper staging of control sequences is correctly performed during start-up, operation, and shutdown to maintain safe working conditions.
- B. Electrical Power Generation. The operation of the Cogeneration system and power distribution switchgear is controlled by the integral control system in the Turbine Generator and the Generator Control Switchgear with input from the CHP Control System. The following paragraphs provide an overview of system electrical operations.
- C. Electrical System Operation.
  1. Combustion Turbine Generator:
    - a. Gas Turbine-Generator shall be capable of fully-automatic operation through its own Turbine Control Panel (TCP). The CTG system shall be capable of communicating with the CHP Control System. . The System Integrator shall provide communication link to the CTG for supervisory control (Start/Stop, Increase/Decrease Voltage, Increase/Decrease Frequency, Synchronize, etc.) and monitoring (Alarms and Trips) in the sequences required by the CTG manufacturer. The System Integrator shall provide hardwired signals to the Turbines for KW set point. As a minimum the CHP Control System interface with the Turbines to obtain the following parameters for each of the new CTGs:
      - 1) Instantaneous Turbine Speed.
      - 2) Instantaneous and accumulated KW hours.
      - 3) Instantaneous Voltage.
      - 4) Instantaneous Frequency.

- 5) Import/export KW control.
- 6) Accumulated hours of CTG operation.
- 7) Turbine fluid drain tank level alarms.
- 8) Oil cooler leak detection alarms.

2. Turbine Loading and Cogeneration:

- a. It is anticipated that the existing site demand on both electric and steam is sufficient at all times to accept the full output of the generator and HRSG, without the duct burner. During periods of higher steam demand, e.g. winter, the duct burner can be modulated to meet the increased demand prior to energizing additional boilers in the adjacent boiler plant. If due to a circumstance where the power generated by the CTG could not be used on site, to prevent backflow of power into the city electrical service, the CTG would be cycled back, based on the input from the electrical power monitoring system.
- b. If steam pressure should rise above a preset high limit while the fired boilers are off, the turbine output will be reduced, in order to reduce the steam output of the HRSG, and that if the steam pressure should rise above a preset high limit, the turbine will be sequenced off (normal shutdown).

D. Mechanical Systems Operation:

1. Heat Recovery Steam Generation System:

- a. Combustion flue gases from the Combustion Gas Turbine-Generator (CTG) are ducted into the Heat Recovery Steam Generator (HRSG) as a main source of energy for production of 100 PSIG saturated steam. The HRSG is equipped with supplemental firing duct burner that can increase steam production up to the specified level. There are no bypass stacks and diverter dampers. Hard-wired interlocks are provided by the CTG and HRSG vendors to insure safe Purge, Light-Off, Operation, and Shutdown of the HRSG and CTG set. The HRSG is equipped with a combination Combustion Control and Burner Management System panel.
- b. The Burner Management System (BMS) portion of the combination panel performs the following major functions:
  - 1) Combustion safety in the starting and stopping of the HRSG natural gas train.
  - 2) Combustion safety in the light-off and stopping of the HRSG duct burner.
  - 3) Flame monitoring and flame scanners cooling equipment operation.
  - 4) Safety of steam drum level and pressure parameters.
- c. The System Integrator shall provide PLC communication links to the Turbine Control Panel and HRSG BMS/Combustion Control Panels for the supervisory control functionality (Start/Stop, Duct Burner On/Off, Increase/Decrease Steam Flow) and monitoring (Alarms and Trips) in the sequences required by the CTG and HRSG manufacturers.
- d. The System Integrator shall provide graphic screens to represent the operation of the entire HRSG duct burner systems. All

values, alarms and warnings generated by the HRSG duct burner system shall be replicated by the CHP Plant PLC system interface that includes HMI/SCADA.

2. Continuous Emissions Monitoring System (CEMS):
  - a. A CEMS console vendor package will be installed to monitor the emissions of the CTG / HRSG. Vendor package shall include all analyzing consoles, controllers, sensors, and HMI terminals for operator access to CEMS.
3. Fuel Gas system:
  - a. Low Pressure Fuel Gas supply to the duct burners will be provided off gas main. HRSG Combustion Control and CHP Control System shall be capable of fully automatic operation of the HRSG natural gas sub-system.
  - b. High Pressure Natural Gas supply to the CTGs will be provided via a gas compressor skid. The gas compressor skid takes suction from the low pressure fuel gas from utility and pressurizes it to high pressure fuel gas used in the CTG. If the Master Fuel Trip / Ammonia Evacuation E-Stop is initiated, the hardwired E-Stop circuit will trip the gas compressor and secure high pressure fuel gas supply to the CTG.
  - c. The CHP Control System will monitor the lower explosive limit (LEL) detectors for natural gas leak detection. If 20% of LEL is reached, the Control System will annunciate an alarm. If 40% of LEL is reached, the system will command the Cogen Plant exhaust fans to run at 100% speed, override the normal fan sequence of operations. If 60% of LEL is reached the system will initiate the safe shutdown of the CTG.
  - d. The System Integrator shall provide graphic screens to monitor supply of fuel gas. All operator interface, values, alarms and warnings generated by the gas distribution system shall be part of the CHP Control System and integrated to the HMI/SCADA.
4. High Pressure Steam System: The System Integrator shall provide direct control and monitoring functionality to maintain a constant steam header pressure. The CHP Control System will send a plant master signal to the HRSG combustion control panel to control the firing rate of the HRSG to maintain a constant steam header pressure. All operator interface, values, alarms and warnings generated by the high pressure steam system shall be part of the CHP Control System and integrated to the SCADA/HMI. The FMCS will send a master steam pressure signal, and the HRSG will normally be the lead, with the existing boilers in lag and fired only when the HRSG cannot meet the site demand at its maximum fired output.
5. Compressed Air System. One (1) CHP Plant air compressor skid will be installed to serve the CHP equipment. Instrument air header pressure transmitter and air dryer alarms will be connected to the CHP Plant Control System for monitoring purposes only. All operator interface, values, alarms and warnings generated by the compressed air system shall be part of the CHP Control System and integrated to the SCADA/HMI.

6. Feedwater Systems:

- a. Feedwater comes from the existing adjacent boiler plant, which included all pretreatment and preheating of the feedwater. A new dedicated pump adjacent to the existing in the existing plant is being provided as part of this contract. The CHP Control System shall control and monitor the feedwater pressure, and operation of the new feed water pump. All operator interface, values, alarms and warnings generated by the new feedwater systems shall be part of the CHP Control System and integrated to the SCADA/HMI.

7. Ammonia Supply System:

- a. A complete ammonia supply, dilution and dosing control system will be supplied as part of the HRSG package to control the injection of ammonia for NOx reduction. The system consists of ammonia supply and reserve bottles, a nitrogen purge bottle and an Ammonia Process Control Unit (APCU).
- b. The APCU receives a flow demand signal and provides and instantaneous flow rate signal to the Combustion Control/BMS panel. The Combustion Control panel also receives a stack NOx signal from the Continuous Emissions Monitoring System (CEMS) and uses this NOx signal to achieve stand-alone control of the ammonia dosing control loop.
- c. The CHP Control System shall monitor via the APCU control panels the following parameters:
  - 1) Instantaneous Ammonia flow rate.
  - 2) Instantaneous Ammonia demand signal.
  - 3) Instantaneous stack NOx level.
- d. The Ammonia bottles are divided up into two (2) banks; primary and secondary. Each bank consists of bottles, a primary pressure switch, a pressure regulator, and an isolation valve, on a common header. The CHP Control System shall control the isolation valves to allow the operator to select which bank of bottles feeds the APCUs.
- e. The CHP Control System shall control a supply block valve and a vent valve at the main ammonia supply. If the Master Fuel Trip / Ammonia Evacuation E-Stop is initiated, the hardwired E-Stop circuit will close the Ammonia Gas Building Supply Block Valve and open the Ammonia Gas Building Supply Vent Valve.
- f. As a minimum the CHP Plant Control System shall directly monitor the following parameters via hardwired signals:
  - 1) Primary ammonia bank low pressure.
  - 2) Secondary ammonia bank low pressure.
  - 3) Ammonia gas building supply pressure.
  - 4) Ammonia gas building supply piping leak detection.

All operator interface, values, alarms and warnings generated by the ammonia supply system shall be part of the CHP Control System and integrated to the SCADA/HMI.

E. E-Stop Circuits:

1. The CHP Control System will have two E-Stop circuits; Turbine Generator CTG/HRSG and Master Fuel Trip / Ammonia Evacuation E-Stop.

2. All E-Stop circuits shall be hardwired directly to the devices to be shutdown. E-Stop circuits shall be normally closed and energized, so that breaking the circuit will initiate shutdown. E-Stop circuits shall be monitored by, but operate independently of the CHP Plant PLC.
3. If initiated the Turbine Generator CTG/HRSG E-Stop will shutdown CTG/HRSG and all related equipment.
4. If initiated the Master Fuel Trip / Ammonia Evacuation E-Stop will:
  - a. Initiate a trip of gas compressors.
  - b. Close the ammonia gas supply block valve and open the ammonia gas supply vent valve.
  - c. Shutdown CTG/HRSG and all related equipment.
5. Hardwired E-Stop Buttons for Turbine Generator CTG/HRSG and Master Fuel Trip / Ammonia Evacuation shall be located on the front of the CHP Plant PLC panel.
  - a. Buttons shall be normally closed red mushroom head push-pull type with protective guard to prevent accidental tripping.
  - b. E-Stop circuits shall be clearly labeled.
  - c. E-Stop wire shall be clearly labeled and separated from panel wiring to prevent accidental tripping.
6. Hardwired E-Stop Buttons for Turbine Generator CTG/HRSG and Master Fuel Trip / Ammonia Evacuation shall be installed in the control room.
  - a. Buttons shall be normally closed red mushroom head push-pull type with protective guard to prevent accidental tripping.
  - b. Buttons should be mounted on the front of a NEMA 4 enclosure mounted in the control room. This enclosure shall have no other purpose other than housing the E-Stop buttons and their associated wiring.
  - c. E-Stop circuits shall be clearly labeled.
  - d. Final location of control room E-Stop buttons shall be at the direction of the Owner or their appointed representative.
7. Two (2) protected push button stations shall be provided for the Master Fuel Trip / Ammonia Evacuation E-Stop on the plant floor level. Locations to be coordinated with the VA.
  - a. Push button stations shall be a red with a lift to access cover.
  - b. Station shall mount on a single gang or 4"x4" electrical box.
  - c. Station push button shall be push to operate and turn to reset.
  - d. E-Stop Stations shall be clearly labeled to indicate function.
  - e. Labeling shall be clearly legible from 20 feet away.

### **3.3 CHP CONTROL MODES**

- A. CHP controls shall be designed to eliminate the necessity for operator actions except auto/manual selection, set point changes, biasing, and similar actions, during normal operation. The control logic shall be designed to incorporate permissive signals, which ensure that the prerequisite conditions for safe operation are met prior to allowing the equipment to start, open, or close, as appropriate. Similarly, the logic shall incorporate interlocks to prevent equipment from operating in an

unsafe or potentially damaging condition. Discrete control logic shall be provided for all motors (pumps, fans, and similar equipment), motor and solenoid operated valves, and auxiliary electric breakers and contactors. Set points and time delays shall be easily assigned and adjusted through the OIT and FMCS/BAS HMI software during start-up and commissioning period.

- B. Hard-Wired Hand-Off-Auto (H-O-A) selectors installed on the field equipment are expected to be switched to Auto position to allow PLC automatic logic to provide normal operation. Hard-Wired H-O-A switches are expected to be utilized in "Hand" or "Off" positions only during maintenance and/or repair activities. The "Hand" position acts directly upon the target device to enable it (in the case of a VFD) or turn it on (in the case of a pump or valve). The "Hand" position status shall not be connected to PLC I/O, however if a "Run" status feedback signal were received without the device being in "Auto" then the device could be said to be "Running Remote" and shall be annunciated on the OIT and FMCS/BAS HMI screens. HMI individual equipment and group control (sequencing) shall generally be classified into the following four modes:
1. HMI Manual Mode (operator control) - In the manual mode the operator shall be required to start/stop or open/close the equipment in response to plant operating needs via the operator workstation/HMI. Equipment that is not frequently operated or equipment which is normally not started without supervision shall only be provided with the manual-control mode.
  2. HMI Automatic Mode - The automatic control mode shall be provided for equipment that must start and stop frequently to maintain process control. As a general rule, actions initiated by automatic logic shall not be annunciated. Failure of an automatic action to occur shall be annunciated if caused by a protective interlock.
  3. HMI Standby Mode - The standby control mode shall be provided for the redundant equipment or equipment which has a designated backup. If equipment is in the standby mode, it shall be started automatically when the operating equipment trips or a process parameter indicates that the operating equipment has failed. Following a standby start, the equipment shall continue to operate until stopped by the operator or until tripped by a protective interlock. When process equipment is taken out of service for maintenance and/or repair services, the PLC shall automatically skip "Out of Service" units in its logic for Lead/Lag assignment, Alarming, Trending, etc. Such equipment shall be clearly identified on HMI Screens via "OUT OF SERVICE" sign and a special graphic identifier (crossed out or gray color).
- C. All equipment shall be provided with the manual control mode. Automatic and standby control modes shall be provided for equipment as appropriate. The control shall be designed to provide bumpless and balanceless transfers between different modes of operation without the need for operator action.
- D. All safety interlocks shall remain in effect in both "Manual" and "Automatic" modes. All Operator defined parameters shall have programmed range limits to prevent spurious values from being accepted. Values outside of range limits shall generate "VALUE NOT VALID" message and prompt for data re-entry.



### **3.4 CHP CONTROL FUNCTIONALITY**

- A. All process control functions shall be programmed in the PLCs and not in HMI package even if required feature is available within HMI. The following functions shall be provided within the CHP Plant PLC:
  - 1. Mathematical - Absolute value, calculate, square root, power, sign, average, totalize.
  - 2. Logic - OR, AND, compare, negate.
  - 3. Fixed Formula - High and low select, span, rate, total, ramp, BTU, enthalpy, wet bulb, relative humidity, and filter.
  - 4. Data Manipulation - Store, file and set.
  - 5. Control Routines - Proportional, integral, differential, lead-lag, split range, cascade, hysteresis correction, and incremental control.
  - 6. Alarms - Process alarm configuration, setpoints, enable/disable, analog signal integrity, and communication alarm configuration.

### **3.5 ALARM HANDLING**

- A. Alarm Indication. Continue alarm indication and annunciation until it is acknowledged. After acknowledgement, continue alarm indication without annunciation until alarm condition is corrected.
- B. Alarm Screen. HMI software shall be configured so that HIHI, HI, LO, LOLO process alarms can be displayed on alarm summary graphics and printed out from alarm printer. Summary HMI screen shall include status of points in alarm condition and date and time stamp of the event. Display multiple alarms in order of occurrence in conjunction with "First Out" functionality. Automatically disable alarm reporting upon associated system shutdown.
- C. List of alarms shall be archived on the SCADA alarm historian server/workstation, and can be retrieved by an operator in a report format approved by the Owner.
- D. All analog alarm points shall be monitored for signal integrity and an alarm shall sound if the signal goes out of specification.
- E. Communication Alarms. The HMI software shall be configured to interface with all vendor supplied control systems and CHP Control System through Ethernet network communication. The communication fault to interface with any Ethernet node shall be programmed, monitored, and displayed on HMI alarm summary graphics when the fault occurs.

### **3.6 CONTROL TYPES**

- A. Supervisory Control. Shall include the HMI screens and network interfacing required to provide status and display of major parameters, setting of major parameters, start/stop commands, and alarm annunciation for the following systems:
  - 1. New Gas Turbine Generator CTG.

2. New Heat Recovery Steam Generator HRSG.
  3. Feedwater systems.
  4. Low pressure fuel gas system.
  5. High pressure fuel gas system.
  6. Compressed air system.
  7. Ammonia supply system.
  8. Turbine fluid drain tank monitoring system.
- B. Direct Control. Shall include the control, HMI screens, alarming, network interfaces required to monitor, control, and display of all process parameters, setting of operator configurable set-points, and start/stop commands for the following systems, equipment and parameters:
1. Steam plant master.
  2. Turbine loading sequence control.
  3. HRSG duct burner control.
  4. Turbine inlet air temperature control loops.
  5. Feed water pressure control loop.
- C. Local Alarms. Alarm displays with alarm horns and strobes shall be installed in different areas throughout the CHP Plant. They shall duplicate messages on the HMI alarm screen at the HMI workstations.
- D. Local on-skid control panels provided by the equipment manufacturers will have their own local alarms. These local equipment alarms shall be acknowledged and resolved by the operators working in the field on the particular skid.

### **3.7 HISTORICAL DATA STORAGE**

- A. Configure the CHP Control software and hardware to allow saving and restoring of the following operating data (minimum 10 TB of historical data):
1. Analog limits and differentials.
  2. Start/stop times.
  3. Access/secure times.
  4. Lockout/unlock times.
  5. Setpoint values and adjustment times.
  6. Limits and differential values.
  7. Totalization points, limits, and current values.
  8. Alarm messages and their assignments.

### **3.8 TRENDING AND REPORTING**

- A. Provide programming which shall allow the VA to:

1. Sample up to one thousand points, real and computed, with each point capable of collecting samples at intervals specified in seconds, minutes, hours, days, or month.
2. Output trend logs as line graphs and bar graphs. Output graphic on PC monitor, with each point for line and bar graphs designated with a unique pattern or color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to twelve columns of one point per column.
3. Historical data logging shall be configured to include all data points from HMI software database. Final points list shall be coordinated with approved by the VA.
4. Collect trend logs that record up to 1000 points at intervals as small as 1 second and for durations as long as two years.
5. Reports shall be generated to summarize the generation and consumption of the CHP plant. As a minimum, reports of the following shall be created:
  - a. CTG power generation.
  - b. Steam generation.
  - c. Fuel gas consumption.
  - d. Make-up water and blow down summary for the CHP plant.
  - e. Equipment runtime summary.
  - f. Plant efficiency reports for the CHP plant.
6. Each report shall be configured with three different time basis: Daily, Monthly, and Weekly.
7. Generate at least six (6) additional automated logs and reports and give the user ability to design additional forms for the future plant needs. All reports shall be coordinated and approved by the Resident Engineer.

### **3.9 OPERATOR INTERFACE**

- A. HMI Development. Coordinate with the VA Palo Alto facilities operation group on HMI development issues such as color convention, object screen sizes, objects animation, etc. prior to finalization. Control logic and operating schemes shall maintain uniformity between different types of equipment as much as possible. High resolution HMI graphic screens shall include:
  1. System Overview - Graphic screens showing overall plant variables and/or alarms of the logical plant area (e.g., electrical one-line diagram, chilled water system, condenser water system, CTG, HRSG gas compressor, etc.).
  2. Schematic Graphics - Graphic screens showing Process Flow Diagram type graphics with dynamic fields of changing data in addition to static fields that represent the physical plant (fixed images of equipment and dynamic data or status displays).
  3. Process Equipment Displays - Process equipment displays shall indicate the operating status of all process equipment as well as the status of all permissives, interlocks and trip functions.

4. Controller Face Plates - Graphic screens presenting groups of process variables, actuation or controllers faceplates. Displayed information shall typically be available when viewing and/or adjusting an analog controller including a Tag Number, Auto/Manual switch, Process Variable, Setpoint, and description. For discrete process variables, an indication of state (e.g., open/closed) shall be displayed.
5. Alarm Summary Screen - Text screen showing list of alarms and trips, their time/date stamp, current status (active, acknowledged, eliminated), etc.

B. Security Measures. Provide at least four different security access levels in the HMI package with log-in names and passwords. Each higher level shall have all the rights and privileges of the corresponding lower level.

1. User - View system status and alarms (lowest access rights).
2. Operator - Control systems and devices.
3. Supervisor - Modify system parameters and settings.
4. Administrator - Programming and configuration of control logic and HMI software (highest access rights).

### **3.10 INTERNAL SYSTEM DIAGNOSTICS AND ALARMS**

A. The CHP Control System, shall have internal diagnostics software to operate concurrently with the monitoring and control functions of the plant process equipment. It shall check for the proper execution of instructions, operation of the system and communications with peripheral devices. Each occurrence of a condition listed below shall result in a unique system malfunction alarm message to be displayed on the Workstation Monitors and Alarm Displays. The following is a minimum list of internal system malfunction alarms:

1. Power supply failure.
2. Communication failure.
3. Software error.
4. Memory error.
5. Processor failure.

B. In addition, all analog points shall be monitored for signal integrity and an alarm shall sound if the signal goes out of specification range.

### **3.11 OFF-SITE INTERFACE**

A. Provide modem connection for a backup means of remote diagnostics and troubleshooting.

### **3.12 CONSTRUCTION WASTE MANAGEMENT**

A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

- B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor's Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

### **3.13 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 01 91 00.01, GENERAL COMMISSIONING REQUIREMENTS and related sections for contractor responsibilities for system commissioning.

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