Department of Veterans Affairs
VISN 22 Network Logistics Office
4811 Airport Plaza Drive, Suite 600
Long Beach, CA 90822

100% Submittal
Specification

Contract VA262-P-1115

Project 600-16-159
A/E Services for "Building 5, Replace Third Boiler (Boiler #1)"
at the VA Long Beach Healthcare Center
Long Beach, California

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September 1, 2016

DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS

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SECTION 01 00 00
GENERAL REQUIREMENTS

1.1 GENERAL INTENTION

A. Contractor shall completely prepare the building including demolition and removal of existing structures, and furnish labor and materials and perform work for the replacement of the existing boilers and associated infrastructure as required by drawings and specifications.

B. Visits to the site by Bidders may be made only by appointment with the Medical Center Engineering Officer.

C. Offices of KAL Architects, Inc., as Architect-Engineers, will render certain technical services during construction. Such services shall be considered as advisory to the Government and shall not be construed as expressing or implying a contractual act of the Government without affirmations by Contracting Officer or his duly authorized representative.

D. Before placement and installation of work subject to tests by testing laboratory retained by Department of Veterans Affairs, the Contractor shall notify the Project Engineer in sufficient time to enable testing laboratory personnel to be present at the site in time for proper taking and testing of specimens and field inspection. Such prior notice shall be not less than three work days unless otherwise designated by the Project Engineer.

E. All employees of General Contractor and Sub-Contractors shall comply with VA security management program and obtain permission of the VA police, be identified by project and employer, and restricted from unauthorized access.

F. Prior to commencing work, General Contractor shall provide proof that a OSHA certified “competent person” (CP) (29 CFR 1926.20(b)(2) will maintain a presence at the work site whenever the General or Sub-Contractors are present.

G. Training:

1. All employees of General Contractor or Sub-Contractors shall have the 10-hour OSHA certified Construction Safety course for on-site staff and 30 additional hours for project superintendent (competent person) and /or other relevant competency training, as determined by VA CP with input from the ICRA team.

2. Submit training records of all such employees for approval before the start of work.

1.2 STATEMENT OF BID ITEM(S)

A. ITEM I, Replacement of Existing Boiler No. 1, including demolition, general construction, mechanical, plumbing, and electrical work, and other improvements as noted on the construction drawings and in the specifications.

B. ITEM 2, Provide new Heat Pump split units for office areas.

1.3 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

A. AFTER AWARD OF CONTRACT, __0___ sets of specifications and drawings will be furnished.

B. Additional sets of drawings may be made by the Contractor, at Contractor's expense, from electronic PDF files.

1.4 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan:

1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.

2. The General Contractor is responsible for assuring that all Sub-Contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

1. General Contractor’s employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.

2. For working outside the “regular hours” as defined in the contract, The General Contractor shall give 3 days notice to the Contracting Officer so that security arrangements can be provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.

3. No photography of VA premises is allowed without written permission of the Contracting Officer.

4. VA reserves the right to close down or shut down the project site and order General Contractor’s employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

C. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the Project Engineer for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.

2. The General Contractor shall turn over all permanent lock cylinders to the VA locksmith for permanent installation. See Section 08 71 00, DOOR HARDWARE and coordinate.

D. Document Control:

1. Before starting any work, the General Contractor/Sub-Contractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of “sensitive information.”

2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.

4. Certain documents, sketches, videos or photographs and drawings may be marked “Law Enforcement Sensitive” or “Sensitive Unclassified.” Secure such information in separate containers and limit the access to only those who will need it for the project. Return the information to the Contracting Officer upon request.

5. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.

6. All paper waste or electronic media such as CD’s and diskettes shall be shredded and destroyed in a manner acceptable to the VA.

7. Notify Contracting Officer and Site Security Officer immediately when there is a loss or compromise of “sensitive information.”

8. All electronic information shall be stored in specified location following VA standards and procedures using an Engineering Document Management Software (EDMS).

    a. Security, access and maintenance of all project drawings, both scanned and electronic shall be performed and tracked through the EDMS system.

    b. “Sensitive information,” including drawings and other documents, may be attached to e-mail provided all VA encryption procedures are followed.

E. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.

2. Separate permits shall be issued for General Contractor and its employees for parking in designated areas only.

1.5 FIRE SAFETY

A. Applicable Publications: Publications listed below form part of this Article to extent referenced. Publications are referenced in text by basic designations only.

1. American Society for Testing and Materials (ASTM):

   E84-2016 .... Surface Burning Characteristics of Building Materials

2. National Fire Protection Association (NFPA):

   10-2013............................... Standard for Portable Fire Extinguishers

   30-2015............................... Flammable and Combustible Liquids Code

   51B-2014 .... Standard for Fire Prevention During Welding, Cutting and Other Hot Work

   70-2014............................... National Electrical Code

   241-2013 .... Standard for Safeguarding Construction, Alteration, and Demolition Operations

3. Occupational Safety and Health Administration (OSHA):

   29 CFR 1926 .... Safety and Health Regulations for Construction

B. Fire Safety Plan: Establish and maintain a fire protection program in accordance with 29 CFR 1926. Prior to start of work, prepare a plan detailing project-specific fire safety measures, including periodic status reports, and submit to Project Engineer and Facility Safety Officer for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Prior to any worker for the Contractor or Sub-Contractors beginning work, they shall undergo a safety briefing provided by the General Contractor’s competent person per OSHA requirements. This briefing shall include information on the construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, etc. Documentation shall be provided to the Project Engineer that individuals have undergone Contractor’s safety briefing.

C. Site and Building Access: Maintain free and unobstructed access to facility emergency services and for fire, police and other emergency response forces in accordance with NFPA 241.

D. Separate temporary facilities, such as trailers, storage sheds, and dumpsters, from existing buildings and new construction by distances in accordance with NFPA 241. For small facilities with less than 6 m (20 feet) exposing overall length, separate by 3m (10 feet).

   1. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.

E. Temporary Construction Partitions:

   1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood (flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire retardant treated wood or metal steel studs. Extend the partitions through suspended ceilings to floor slab deck or roof. Seal joints and penetrations. At door openings install Class C ¾ hour fire/smoke rated doors with self-closing devices.

   2. Install one-hour fire-rated temporary construction partitions as shown on drawings to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.

   3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.

F. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 70, and NFPA 241.

G. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with Project Engineer and facility Safety Officer.

H. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to Project Engineer and facility Safety Officer.

I. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 10, and NFPA 241.

J. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 30, and NFPA 241.

K. Sprinklers: Install, test and activate new automatic sprinklers prior to removing existing sprinklers.

L. Existing Fire Protection: Do not impair automatic sprinklers, smoke and heat detection, and fire alarm systems, except for portions immediately under construction, and temporarily for connections. Provide fire watch for impairments more than 4 hours in a 24-hour period. Request interruptions in accordance with Article, OPERATIONS AND STORAGE AREAS, and coordinate with Project Engineer and facility Safety Officer. All existing or temporary fire protection systems (fire alarms, sprinklers) located in construction areas shall be tested as coordinated with the medical center. Parameters for the testing and results of any tests performed shall be recorded by the medical center and copies provided to the Project Engineer.

M. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with Project Engineer and facility Safety Officer.

N. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 51B and NFPA 241. Coordinate with Project Engineer. Obtain permits from facility Safety Officer at least __24__ hours in advance. Designate Contractor's responsible project-site fire prevention program manager to permit hot work.

O. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to Project Engineer and facility Safety Officer.

P. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.

Q. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.

R. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.

S. If required, submit documentation to the Project Engineer that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

T. Fines for violations of Fire Safety Requirements:

1. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.

2. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.

3. Tripping, setting off, of fire alarms and /or flow switches, without proper notification is a violation fineable at the minimum of $2,500 per offense plus expenses.

4. Smoke detectors that were bagged, covered, or any way rendered inoperable during work shift must be made operable at the end of said work shift. This offense is fineable at the minimum of $2,500 per offense plus expenses.

5. Any false alarms that causes a visit by the fire department is fineable at the minimum of $2,500 per offense plus expenses.

6. Hot Work: The following offenses are a violation fineable at a minimum of $2,500 per offense plus expenses: a) Failure to obtain a hot work permit prior to work, b) Failure to maintain Fire Watch, as required during Hot Work, and c) Failure to remove smoke detector cover after said Hot Work is completed at the end of the work shift for the day, whichever is sooner.

7. Fines for Open Fire Doors: Fire doors at all times shall be kept closed, where required. These doors shall not be left open in any manner; they shall not be propped or tied open. Violations are fineable at no less than $2,500 per violation plus expenses. These fines will be imposed due to Contractor’s fault, negligence, or failure to comply with NFPA codes and VA Policies.

1.6 OPERATIONS AND STORAGE AREAS

A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.

B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.

C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any federal, state, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

D. Working space and space available for storing materials shall be as shown on the drawings.

E. Construction personnel are subject to the rules of the Medical Center applicable to their conduct while on the Medical Center premises.

F. Execute work so as to interfere as little as possible with normal functioning of Medical Center as a whole, including operations of utility services, fire protection systems, and any existing equipment, and with work being done by others.

1. Do not store materials and equipment in other than assigned areas.

2. Schedule delivery of materials and equipment to immediate construction working areas within buildings in use by Department of Veterans Affairs in quantities sufficient for not more than two work days. Provide unobstructed access to Medical Center areas required to remain in operation.

3. Where access by Medical Center personnel to vacated portions of buildings is not required, storage of Contractor's materials and equipment will be permitted subject to fire and safety requirements.

G. Phasing: To insure such executions, Contractor shall furnish the Project Engineer with a schedule of approximate phasing dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof. In addition, Contractor shall notify the Project Engineer two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Coordinate with other on-going Boiler Replacement Contract work in the Building. Arrange such phasing dates to ensure accomplishment of this work in successive phases mutually agreeable to Medical Center Director, Project Engineer, and Contractor as follows:

Phase I: Replace existing Boiler #1 and other related work.

H. Building No. __5_____ will be occupied during performance of work.

Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in the Medical Centers operations will not be hindered. Contractor shall permit access to Department of Veterans Affairs personnel and patients through other construction areas which serve as routes of access to such affected areas and equipment. Coordinate alteration work in areas occupied by Department of

Veterans Affairs so that Medical Center operations will continue during the construction period.

2. Immediate areas of alterations not mentioned in preceding Subparagraph 1 will be temporarily vacated while alterations are performed.

I. Construction Fence: Before construction operations begin, Contractor shall provide a chain link construction fence, 2.1 m (seven feet) minimum height, around the construction area indicated on the drawings. Provide gates as required for access with necessary hardware, including hasps and padlocks. Fasten fence fabric to terminal posts with tension bands and to line posts and top and bottom rails with tie wires spaced at maximum 375 mm (15 inches). Bottom of fences shall extend to 25 mm (one inch) above grade. Remove the fence when directed by Project Engineer.

J. When a building is turned over to Contractor, Contractor shall accept entire responsibility therefor.

1. Contractor shall maintain a minimum temperature of 4 degrees C (40 degrees F) at all times, except as otherwise specified.

2. Contractor shall maintain in operating condition existing fire protection and alarm equipment. In connection with fire alarm equipment Contractor shall make arrangements for pre-inspection of site with Fire Department or Company (Department of Veterans Affairs or municipal), whichever will be required to respond to an alarm from Contractor's employee or watchman.

K. Utilities Services: Maintain existing utility services for Medical Center at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer or air pipes, or conduits, wires, cables, etc. of utility services, or of fire protection systems and communications systems (including telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by Project Engineer.

1. No utility service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of Project Engineer. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished, work on any energized circuits or equipment shall not commence without the Medical Center Director’s prior knowledge and written approval. Refer to specification Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS for additional requirements.

2. Contractor shall submit a request to interrupt any such services to Project Engineer, in writing, at least 48 hours in advance of proposed interruption. Request shall state reason, date, exact time of, and anticipated approximate duration of such interruption.

3. Contractor will be advised (in writing) of approval of request, or of which other date and/or time such interruption will cause least inconvenience to operations of Medical Center. Interruption time approved by Medical Center may occur at other than Contractor's normal working hours.

4. Major interruptions of any system must be requested, in writing, at least 15 calendar days prior to the desired time and shall be performed as directed by the Project Engineer.

5. In case of a contract construction emergency, service will be interrupted on approval of Project Engineer. Such approval will be confirmed in writing as soon as practical.

6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.

L. Abandoned Lines: All service lines such as wires, cables, conduits, ducts, pipes and the like, and their hangers or supports, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged. The lines shall not be capped in finished areas, but shall be removed and sealed, capped or plugged in ceilings, within furred spaces, in unfinished areas, or within walls or partitions; so that they are completely behind the finished surfaces.

M. To minimize interference of construction activities with flow of Medical Center traffic, comply with the following:

1. Keep roads, walks, and entrances to grounds, to parking, and to occupied areas of buildings clear of construction materials, debris, and standing construction equipment and vehicles.

N. Coordinate the work for this contract with other construction operations as directed by Project Engineer. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

1.7 ALTERATIONS

A. Survey: Before any work is started, the Contractor shall make a thorough survey with the Project Engineer of areas of buildings in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by both, to the Contracting Officer. This report shall list by rooms and spaces:

1. Existing condition and types of resilient flooring, doors, windows, walls and other surfaces not required to be altered throughout affected areas of building.

2. Existence and conditions of items such as plumbing fixtures and accessories, electrical fixtures, equipment, etc., required by drawings to be either reused or relocated, or both.

3. Shall note any discrepancies between drawings and existing conditions at site.

4. Shall designate areas for working space, materials storage and routes of access to areas within buildings where alterations occur and which have been agreed upon by Contractor and Project Engineer.

B. Any items required by drawings to be either reused or relocated or both, found during this survey to be nonexistent, or in opinion of Project Engineer, to be in such condition that their use is impossible or impractical, shall be furnished and/or replaced by Contractor with new items in accordance with specifications which will be furnished by Government. Provided the contract work is changed by reason of this subparagraph B, the contract will be modified accordingly, under provisions of clause entitled "DIFFERING SITE CONDITIONS" (FAR 52.236-2) and "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).

C. Re-Survey: Thirty days before expected partial or final inspection date, the Contractor and Project Engineer together shall make a thorough re-survey of the areas of buildings involved. They shall furnish a report on conditions then existing, of resilient flooring, doors, windows, walls and other surfaces as compared with conditions of same as noted in first condition survey report:

1. Re-survey report shall also list any damage caused by Contractor to such flooring and other surfaces, despite protection measures; and, will form basis for determining extent of repair work required of Contractor to restore damage caused by Contractor's workers in executing work of this contract.

D. Protection: Provide the following protective measures:

1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.

2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.

3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

1.8 INFECTION PREVENTION MEASURES

A. Implement the requirements of VAMC's Infection Control Risk Assessment (ICRA) team. ICRA Group may monitor dust in the vicinity of the construction work and require the Contractor to take corrective action immediately if the safe levels are exceeded.

B. Establish and maintain a dust control program as part of the Contractor's infection preventive measures in accordance with the guidelines provided by ICRA Group. Prior to start of work, prepare a plan detailing project-specific dust protection measures, including periodic status reports, and submit to Project Engineer for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

1. All personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.

C. Medical Center Infection Control personnel shall monitor for airborne disease (e.g. aspergillosis) as appropriate during construction. A baseline of conditions may be established by the Medical Center prior to the start of work and periodically during the construction stage to determine impact of construction activities on indoor air quality. In addition:

1. The Project Engineer and VAMC Infection Control personnel shall review pressure differential monitoring documentation to verify that pressure differentials in the construction zone and in the patient-care rooms are appropriate for their settings. The requirement for negative air pressure in the construction zone shall depend on the location and type of activity. Upon notification, the Contractor shall implement corrective measures to restore proper pressure differentials as needed.

2. In case of any problem, the medical center, along with assistance from the Contractor, shall conduct an environmental assessment to find and eliminate the source.

D. In General, following preventive measures shall be adopted during construction to keep down dust and prevent mold.

1. Dampen debris to keep down dust and provide temporary construction partitions in existing structures where directed by Project Engineer. Blank off ducts and diffusers to prevent circulation of dust into occupied areas during construction.

2. Do not perform dust producing tasks within occupied areas without the approval of the Project Engineer. For construction in any areas that will remain jointly occupied by the Medical Center and Contractor's workers, the Contractor shall:

a. Provide dust proof temporary drywall construction barriers to completely separate construction from the operational areas of the Medical Center in order to contain dirt debris and dust. Barriers shall be sealed and made presentable on hospital occupied side. Install a self-closing rated door in a metal frame, commensurate with the partition, to allow worker access. Maintain negative air at all times. A fire retardant polystyrene, 6-mil thick or greater plastic barrier meeting local fire codes may be used where dust control is the only hazard, and an agreement is reached with the Project Engineer and Medical Center.

b. HEPA filtration is required where the exhaust dust may reenter the breathing zone. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents, or building openings. Install HEPA (High Efficiency Particulate Accumulator) filter vacuum system rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. Insure continuous negative air pressures occurring within the work area. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and secondary filtrations units. Exhaust hoses shall be heavy duty, flexible steel reinforced and exhausted so that dust is not reintroduced to the medical center.

c. Adhesive Walk-off/Carpet Walk-off Mats, minimum 600 x 900 mm (24 x 36 inches), shall be used at all interior transitions from the construction area to occupied medical center area. These mats shall be changed as often as required to maintain clean work areas directly outside construction area at all times.

d. Vacuum and wet mop all transition areas from construction to the occupied medical center at the end of each workday. Vacuum shall utilize HEPA filtration. Maintain surrounding area frequently. Remove debris as they are created. Transport these outside the construction area in containers with tightly fitting lids.

e. The Contractor shall not haul debris through patient-care areas without prior approval of the Project Engineer and the Medical Center. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with duct tape. No sharp objects should be allowed to cut through the plastic. Wipe down the exterior of the containers with a damp rag to remove dust. All equipment, tools, material, etc. transported through occupied areas shall be made free from dust and moisture by vacuuming and wipe down.

f. Using a HEPA vacuum, clean inside the barrier and vacuum ceiling tile prior to replacement. Any ceiling access panels opened for investigation beyond sealed areas shall be sealed immediately when unattended.

g. There shall be no standing water during construction. This includes water in equipment drip pans and open containers within the construction areas. All accidental spills must be cleaned up and dried within 12 hours. Remove and dispose of porous materials that remain damp for more than 72 hours.

h. At completion, remove construction barriers and ceiling protection carefully, outside of normal work hours. Vacuum and clean all surfaces free of dust after the removal.

E. Final Cleanup:

1. Upon completion of project, or as work progresses, remove all construction debris from above ceiling, vertical shafts and utility chases that have been part of the construction.

2. Perform HEPA vacuum cleaning of all surfaces in the construction area. This includes walls, ceilings, cabinets, furniture (built-in or free standing), partitions, flooring, etc.

3. All new air ducts shall be cleaned prior to final inspection.

1.9 DISPOSAL AND RETENTION

A. Materials and equipment accruing from work removed and from demolition of buildings or structures, or parts thereof, shall be disposed of as follows:

1. Reserved items which are to remain property of the Government are identified by attached tags or noted on drawings or in specifications as items to be stored. Items that remain property of the Government shall be removed or dislodged from present locations in such a manner as to prevent damage which would be detrimental to re-installation and reuse. Store such items where directed by Project Engineer.

2. Items not reserved shall become property of the Contractor and be removed by Contractor from Medical Center.

3. Items of portable equipment and furnishings located in rooms and spaces in which work is to be done under this contract shall remain the property of the Government. When rooms and spaces are vacated by the Department of Veterans Affairs during the alteration period, such items which are NOT required by drawings and specifications to be either relocated or reused will be removed by the Government in advance of work to avoid interfering with Contractor's operation.

4. PCB Transformers and Capacitors: The Contractor shall be responsible for disposal of the Polychlorinated Biphenyl (PCB) transformers and capacitors. The transformers and capacitors shall be taken out of service and handled in accordance with the procedures of

the Environmental Protection Agency (EPA) and the Department of Transportation (DOT) as outlined in Code of Federal Regulation (CFR), Titled 40 and 49 respectively. The EPA's Toxic Substance Control Act (TSCA) Compliance Program Policy Nos. 6-PCB-6 and 6-PCB-7 also apply. Upon removal of PCB transformers and capacitors for disposal, the "originator" copy of the Uniform Hazardous Waste Manifest (EPA Form 8700-22), along with the Uniform Hazardous Waste Manifest Continuation Sheet (EPA Form 8700-22A) shall be returned to the Contracting Officer who will annotate the contract file and transmit the Manifest to the Medical Center's.

a. Copies of the following listed CFR titles may be obtained from the Government Printing Office:

40 CFR 261..................Identification and Listing of Hazardous Waste

40 CFR 262..................Standards Applicable to Generators of Hazardous Waste

40 CFR 263..................Standards Applicable to Transporters of Hazardous Waste

40 CFR 761..................PCB Manufacturing, Processing, Distribution in Commerce, and use Prohibitions

49 CFR 172..................Hazardous Material tables and Hazardous Material Communications Regulations

49 CFR 173..................Shippers - General Requirements for Shipments and Packaging

49 CRR 173 ....Subpart A General

49 CFR 173..................Subpart B Preparation of Hazardous Material for Transportation

49 CFR 173..................Subpart J Other Regulated Material; Definitions and Preparation

TSCA............................Compliance Program Policy Nos. 6-PCB-6 and 6-PCB-7

1.10 PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS

A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workers, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.

B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

C. Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements.

D. Refer to FAR clause 52.236-7, "Permits and Responsibilities," which is included in General Conditions. A National Pollutant Discharge Elimination System (NPDES) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will make the permit application available at the (appropriate medical center) office. The apparent low bidder, Contractor and affected Sub-Contractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, but are not limited to the following:

- Designating areas for equipment maintenance and repair;
- Providing waste receptacles at convenient locations and provide regular collection of wastes;
- Locating equipment wash down areas on site, and provide appropriate control of wash-waters;
- Providing protected storage areas for chemicals, paints, solvents, fertilizers, and other potentially toxic materials; and
- Providing adequately maintained sanitary facilities.

1.11 RESTORATION

A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of the Project Engineer. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the Project Engineer before it is disturbed. Materials and workmanship used in restoring work, shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

B. Upon completion of contract, deliver work complete and undamaged. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work.

C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workers to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are indicated on drawings and which are not scheduled for discontinuance or abandonment.

D. Expense of repairs to such utilities and systems not shown on drawings or locations of which are unknown will be covered by adjustment to contract time and price in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88) and "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.12 AS-BUILT DRAWINGS

A. The Contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications.

B. All variations shall be shown in the same General detail as used in the contract drawings. To insure compliance, as-built drawings shall be made available for the Project Engineer's review, as often as requested.

C. Contractor shall deliver two approved completed sets of as-built drawings to the Project Engineer within 15 calendar days after each completed phase and after the acceptance of the project by the Project Engineer.

D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.13 USE OF ROADWAYS

A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the Project Engineer, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.

B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.

C. When certain buildings (or parts of certain buildings) are required to be completed in advance of general date of completion, all roads leading thereto must be completed and available for use at time set for completion of such buildings or parts thereof.

1.15 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to compliance with the following provisions:

1. Permission to use each unit or system must be given by Project Engineer. If the equipment is not installed and maintained in accordance with the following provisions, the Project Engineer will withdraw permission for use of the equipment.

2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers, and their overload elements shall be properly sized, coordinated and adjusted. Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.

3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.

4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.

5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.

6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in temporary service shall be cleaned prior to use; maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government. Boilers, pumps, feedwater heaters, and auxiliary equipment must be operated as a complete system and be fully maintained by operating personnel. Boiler water must be given complete and continuous chemical treatment.

B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.

C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.

1.16 TEMPORARY TOILETS

A. Provide where directed, (for use of all Contractor's workers) ample temporary sanitary toilet accommodations with suitable sewer and water connections; or, when approved by Project Engineer, provide suitable dry closets where directed. Keep such places clean and free from flies, and all connections and appliances connected therewith are to be removed prior to completion of contract, and premises left perfectly clean.

1.17 AVAILABILITY AND USE OF UTILITY SERVICES

A. The Government shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The amount to be paid by the Contractor for chargeable electrical services shall be the prevailing rates charged to the Government. The Contractor shall carefully conserve any utilities furnished without charge.

B. The Contractor, at Contractor's expense and in a workmanlike manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of electricity used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.

C. Contractor shall install meters at Contractor's expense and furnish the Medical Center a monthly record of the Contractor's usage of electricity as hereinafter specified.

D. Heat: Furnish temporary heat necessary to prevent injury to work and materials through dampness and cold. Use of open salamanders or any temporary heating devices which may be fire hazards or may smoke and damage finished work, will not be permitted. Maintain minimum temperatures as specified for various materials:

1. Obtain heat by connecting to Medical Center heating distribution system.

    a. Steam is available at no cost to Contractor.

E. Electricity (for Construction and Testing): Furnish all temporary electric services.

1. Obtain electricity by connecting to the Medical Center electrical distribution system. The Contractor shall meter and pay for electricity required for electric cranes and hoisting devices, electrical welding devices and any electrical heating devices providing temporary heat. Electricity for all other uses is available at no cost to the Contractor.

F. Water (for Construction and Testing): Furnish temporary water service.

1. Obtain water by connecting to the Medical Center water distribution system. Provide reduced pressure backflow preventer at each connection. Water is available at no cost to the Contractor.

2. Maintain connections, pipe, fittings and fixtures and conserve water-use so none is wasted. Failure to stop leakage or other wastes will be cause for revocation (at Project Engineer's discretion) of use of water from Medical Center's system.

G. Steam: Furnish steam system for testing required in various sections of specifications.

1. Obtain steam for testing by connecting to the Medical Center steam distribution system. Steam is available at no cost to the Contractor.

2. Maintain connections, pipe, fittings and fixtures and conserve steam-use so none is wasted. Failure to stop leakage or other waste will be cause for revocation (at Project Engineer's discretion), of use of steam from the Medical Center's system.

H. Fuel: Natural and LP gas and burner fuel oil required for boiler cleaning, normal initial boiler-burner setup and adjusting, and for performing the specified boiler tests will be furnished by the Government. Fuel required for prolonged boiler-burner setup, adjustments, or modifications due to improper design or operation of boiler, burner, or control devices shall be furnished by the Contractor at Contractor's expense.

1.18 NEW TELEPHONE EQUIPMENT

A. The Contractor shall coordinate with the work of installation of telephone equipment by others. This work shall be completed before the building is turned over to VA.

1.19 TESTS

A. Pre-test mechanical and electrical equipment and systems and make corrections required for proper operation of such systems before requesting final tests. Final test will not be conducted unless pre-tested.

B. Conduct final tests required in various sections of specifications in presence of an authorized representative of the Contracting Officer. Contractor shall furnish all labor, materials, equipment, instruments, and forms, to conduct and record such tests.

C. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire complex 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 part of entire system which provides comfort conditions for a building. Other related components are return air, exhaust air, steam, chilled water, refrigerant, hot water, controls and electricity, etc. Another example of a complex which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate, and other related components.

D. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably short period of time during which operating and environmental conditions remain reasonably constant.

E. Individual test result of any component, where required, will only be accepted when submitted with the test results of related components and of the entire system.

1.20 INSTRUCTIONS

A. Contractor shall furnish Maintenance and Operating manuals and verbal instructions when required by the various sections of the specifications and as hereinafter specified.

B. Manuals: Maintenance and operating manuals (four copies each) for each separate piece of equipment shall be delivered to the Project Engineer coincidental with the delivery of the equipment to the job site. Manuals shall be complete, detailed guides for the maintenance and operation of equipment. They shall include complete information necessary for starting, adjusting, maintaining in continuous operation for long periods of time and dismantling and reassembling of the complete units and sub-assembly components. Manuals shall include an index covering all component parts clearly cross-referenced to diagrams and illustrations. Illustrations shall include "exploded" views showing and identifying each separate item. Emphasis shall be placed on the use of special tools and instruments. The function of each piece of equipment, component, accessory and control shall be clearly and thoroughly explained. All necessary precautions for the operation of the equipment and the reason for each precaution shall be clearly set forth. Manuals must reference the exact model, style and size of the piece of equipment and system being furnished. Manuals referencing equipment similar to but of a different model, style, and size than that furnished will not be accepted.

C. Instructions: Contractor shall provide qualified, factory-trained manufacturers' representatives to give detailed instructions to assigned Department of Veterans Affairs personnel in the operation and complete maintenance for each piece of equipment. All such training will be at the job site. These requirements are more specifically detailed in the various technical sections. Instructions for different items of equipment that are component parts of a complete system, shall be given in an integrated, progressive manner. All instructors for every piece of component equipment in a system shall be available until instructions for all items included in the system have been completed. This is to assure proper instruction in the operation of inter-related systems. All instruction periods shall be at such times as scheduled by the Project Engineer and shall be considered concluded only when the Project Engineer is satisfied in regard to complete and thorough coverage. The Department of Veterans Affairs reserves the right to request the removal of, and substitution for, any instructor who, in the opinion of the Project Engineer, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

1.22 SAFETY SIGN

A. Provide a Safety Sign where directed by Project Engineer. Face of sign shall be 19 mm (3/4 inch) thick exterior grade plywood. Provide two 100 x 100 mm (4 x 4 inch) posts extending full height of sign and 900 mm (3 feet) into ground. Set bottom of sign level at 1200 mm (4 feet) above ground.

B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted.

C. Maintain sign and remove it when directed by Project Engineer.

D. Standard Detail Drawing Number SD10000-02 (Found on VA TIL) of safety sign showing required legend and other characteristics of sign is attached hereto and is made a part of this specification.

E. Post the number of accident free days on a daily basis.

1.23 PHOTOGRAPHIC DOCUMENTATION

A. During the construction period through completion, provide photographic documentation of construction progress and at selected milestones including electronic indexing, navigation, storage and remote access to the documentation, as per these specifications. The commercial photographer or the Sub-Contractor used for this work shall meet the following qualifications:

1. Demonstrable minimum experience of three (3) years in operation providing documentation and advanced indexing/navigation systems including a representative portfolio of construction projects of similar type, size, duration and complexity as the Project.

2. Demonstrable ability to service projects throughout North America, which shall be demonstrated by a representative portfolio of active projects of similar type, size, duration and complexity as the Project.

B. Photographic documentation elements:

1. Each digital image shall be taken with a professional grade camera with minimum size of 6 megapixels (MP) capable of producing 200 x 250mm (8 x 10 inch) prints with a minimum of 2272 x 1704 pixels and 400 x 500mm (16 x 20 inch) prints with a minimum 2592 x 1944 pixels.

2. Indexing and navigation system shall utilize actual AUTOCAD construction drawings, making such drawings interactive on an on-line interface. For all documentation referenced herein, indexing and navigation must be organized by both time (date-stamped) and location throughout the project.

3. Documentation shall combine indexing and navigation system with inspection-grade digital photography designed to capture actual conditions throughout construction and at critical milestones. Documentation shall be accessible on-line through use of an internet connection. Documentation shall allow for secure multiple-user access, simultaneously, on-line.

4. Before construction, the building pad, adjacent streets, roadways, parkways, driveways, curbs, sidewalks, landscaping, adjacent utilities and adjacent structures surrounding the building pad and site shall be documented. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings. If site work or pad preparation is extensive, this documentation may be required immediately before construction and at several pre-determined intervals before building work commences.

5. Construction progress for all trades shall be tracked at pre-determined intervals, but not less than once every thirty (30) calendar days (“Progressions”). Progression documentation shall track both the exterior and interior construction of the building. Exterior Progressions shall track 360 degrees around the site and each building. Interior Progressions shall track interior improvements beginning when stud work commences and continuing until Project completion.

6. As-built condition of pre-slab utilities and site utilities shall be documented prior to pouring slabs, placing concrete and/or backfilling. This process shall include all underground and in-slab utilities within the building(s) envelope(s) and utility runs in the immediate vicinity of the building(s) envelope(s). This may also include utilities enclosed in slab-on-deck in multi-story buildings. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive site utility plans.

7. As-built conditions of mechanical, electrical, plumbing and all other systems shall be documented post-inspection and pre-insulation, sheet rock or dry wall installation. This process shall include all finished systems located in the walls and ceilings of all buildings at the Project. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.

8. As-built conditions of exterior skin and elevations shall be documented with an increased concentration of digital photographs as directed by the Project Engineer in order to capture pre-determined focal points, such as waterproofing, window flashing, radiused steel work, architectural or Exterior Insulation and Finish Systems (EIFS) detailing. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive elevations or elevation details.

9. As-built finished conditions of the interior of each building including floors, ceilings and walls shall be documented at certificate of occupancy or equivalent, or just prior to occupancy, or both, as directed by the Project Engineer. Overlapping photographic techniques shall be used to insure maximum coverage. Indexing and navigation accomplished through interactive architectural drawings.

10. Miscellaneous events that occur during any Contractor site visit, or events captured by the Department of Veterans Affairs independently, shall be dated, labeled and inserted into a Section in the navigation structure entitled “Slideshows,” allowing this information to be stored in the same “place” as the formal scope.

11. Customizable project-specific digital photographic documentation of other details or milestones. Indexing and navigation accomplished through interactive architectural plans.

12. Monthly (29 max.) exterior progressions (360 degrees around the project) and slideshows (all elevations and building envelope). The slideshows allow for the inclusion of Department of Veterans Affairs pictures, aerial photographs, and timely images which do not fit into any regular monthly photopath.

13. Weekly (21 max.) Site Progressions - Photographic documentation capturing the project at

different stages of construction. These progressions shall capture underground utilities, excavation, grading, backfill, landscaping and road construction throughout the duration of the project.

14. Regular (8 max.) interior progressions of all walls of the entire project to begin at time of substantial framed or as directed by the Project Engineer through to completion.

15. Detailed Exact-Built of all Slabs for all project slab pours just prior to placing concrete or as directed by the Project Engineer.

16. Detailed Interior exact built overlapping photos of the entire building to include documentation of all mechanical, electrical and plumbing systems in every wall and ceiling, to be conducted after rough-ins are complete, just prior to insulation and or drywall, or as directed by Project Engineer.

17. Finished detailed Interior exact built overlapping photos of all walls, ceilings, and floors to be scheduled by Project Engineer prior to occupancy.

18. In event a greater or lesser number of images than specified above are required by the Project Engineer, adjustment in contract price will be made in accordance with clause entitled "CHANGES" (FAR 52.243-4 and VAAR 852.236-88).

C. Images shall be taken by a commercial photographer and must show distinctly, at as large a scale as possible, all parts of work embraced in the picture.

D. Coordination of photo shoots is accomplished through Project Engineer. Contractor shall also attend construction team meetings as necessary. Contractor’s operations team shall provide regular updates regarding the status of the documentation, including photo shoots concluded, the availability of new Progressions or Exact-Builts viewable on-line and anticipated future shoot dates.

E. Contractor shall provide all on-line domain/web hosting, security measures, and redundant server back-up of the documentation.

F. Contractor shall provide technical support related to using the system or service.

G. Upon completion of the project, final copies of the documentation (the “Permanent Record”) with the indexing and navigation system embedded (and active) shall be provided in an electronic media format, typically a DVD or external hard-drive. On-line access terminates upon delivery of the Permanent Record.

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SECTION 01 33 23
SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

1-1. Refer to Articles titled SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FAR 52.236-21) and, SPECIAL NOTES (VAAR 852.236-91), in GENERAL CONDITIONS.

1-2. For the purposes of this contract, samples (including laboratory samples to be tested), test reports, certificates, and manufacturers' literature and data shall also be subject to the previously referenced requirements. The following text refers to all items collectively as SUBMITTALS.

1-3. Submit for approval, all of the items specifically mentioned under the separate sections of the specification, with information sufficient to evidence full compliance with contract requirements. Materials, fabricated articles and the like to be installed in permanent work shall equal those of approved submittals. After an item has been approved, no change in brand or make will be permitted unless:

A. Satisfactory written evidence is presented to, and approved by Contracting Officer, that manufacturer cannot make scheduled delivery of approved item or;
B. Item delivered has been rejected and substitution of a suitable item is an urgent necessity or;
C. Other conditions become apparent which indicates approval of such substitute item to be in best interest of the Government.

1-4. Forward submittals in sufficient time to permit proper consideration and approval action by Government. Time submission to assure adequate lead time for procurement of contract - required items. Delays attributable to untimely and rejected submittals (including any laboratory samples to be tested) will not serve as a basis for extending contract time for completion.

1-5. Submittals will be reviewed for compliance with contract requirements by Architect-Engineer, and action thereon will be taken by Resident Engineer on behalf of the Contracting Officer.

1-6. Upon receipt of submittals, Architect-Engineer will assign a file number thereto. Contractor, in any subsequent correspondence, shall refer to this file and identification number to expedite replies relative to previously approved or disapproved submittals.

1-7. The Government reserves the right to require additional submittals, whether or not particularly mentioned in this contract. If additional submittals beyond those required by the contract are furnished pursuant to request therefor by Contracting Officer, adjustment in contract price and time will be made in accordance with Articles titled CHANGES (FAR 52.243-4) and CHANGES - SUPPLEMENT (VAAR 852.236-88) of the GENERAL CONDITIONS.

1-8. Schedules called for in specifications and shown on shop drawings shall be submitted for use and information of Department of Veterans Affairs and Architect-Engineer. However, the Contractor shall assume responsibility for coordinating and verifying schedules. The Contracting

Officer and Architect- Engineer assumes no responsibility for checking schedules or layout drawings for exact sizes, exact numbers and detailed positioning of items.

1-9. Submittals must be submitted by Contractor only and shipped prepaid. Contracting Officer assumes no responsibility for checking quantities or exact numbers included in such submittals.

A. Submit samples in single units unless otherwise specified. Submit shop drawings, schedules, manufacturers' literature and data, and certificates in quadruplicate, except where a greater number is specified.

B. Submittals will receive consideration only when covered by a transmittal letter signed by Contractor. Letter shall be sent via first class mail and shall contain the list of items, name of Medical Center, name of Contractor, contract number, applicable specification paragraph numbers, applicable drawing numbers (and other information required for exact identification of location for each item), manufacturer and brand, ASTM or Federal Specification Number (if any) and such additional information as may be required by specifications for particular item being furnished. In addition, catalogs shall be marked to indicate specific items submitted for approval.

1. A copy of letter must be enclosed with items, and any items received without identification letter will be considered "unclaimed goods" and held for a limited time only.
2. Each sample, certificate, manufacturers' literature and data shall be labeled to indicate the name and location of the Medical Center, name of Contractor, manufacturer, brand, contract number and ASTM or Federal Specification Number as applicable and location(s) on project.
3. Required certificates shall be signed by an authorized representative of manufacturer or supplier of material, and by Contractor.

C. In addition to complying with the applicable requirements specified in preceding Article 1.9, samples which are required to have Laboratory Tests (those preceded by symbol "LT" under the separate sections of the specification shall be tested, at the expense of Contractor, in a commercial laboratory approved by Contracting Officer.

1. Laboratory shall furnish Contracting Officer with a certificate stating that it is fully equipped and qualified to perform intended work, is fully acquainted with specification requirements and intended use of materials and is an independent establishment in no way connected with organization of Contractor or with manufacturer or supplier of materials to be tested.
2. Certificates shall also set forth a list of comparable projects upon which laboratory has performed similar functions during past five years.
3. Samples and laboratory tests shall be sent directly to approved commercial testing laboratory.
4. Contractor shall send a copy of transmittal letter to both Resident Engineer and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
5. Laboratory test reports shall be sent directly to Resident Engineer for appropriate action.

6. Laboratory reports shall list contract specification test requirements and a comparative list of the laboratory test results. When tests show that the material meets specification requirements, the laboratory shall so certify on test report.
7. Laboratory test reports shall also include a recommendation for approval or disapproval of tested item.

D. If submittal samples have been disapproved, resubmit new samples as soon as possible after notification of disapproval. Such new samples shall be marked "Resubmitted Sample" in addition to containing other previously specified information required on label and in transmittal letter.

E. Approved samples will be kept on file by the Resident Engineer at the site until completion of contract, at which time such samples will be delivered to Contractor as Contractor's property. Where noted in technical sections of specifications, approved samples in good condition may be used in their proper locations in contract work. At completion of contract, samples that are not approved will be returned to Contractor only upon request and at Contractor's expense. Such request should be made prior to completion of the contract. Disapproved samples that are not requested for return by Contractor will be discarded after completion of contract.

F. Submittal drawings (shop, erection or setting drawings) and schedules, required for work of various trades, shall be checked before submission by technically qualified employees of Contractor for accuracy, completeness and compliance with contract requirements. These drawings and schedules shall be stamped and signed by Contractor certifying to such check.

1. For each drawing required, submit one legible photographic paper or vellum reproducible.
2. Reproducible shall be full size.
3. Each drawing shall have marked thereon, proper descriptive title, including Medical Center location, project number, manufacturer's number, reference to contract drawing number, detail Section Number, and Specification Section Number.
4. A space 120 mm by 125 mm (4-3/4 by 5 inches) shall be reserved on each drawing to accommodate approval or disapproval stamp.
5. Submit drawings, ROLLED WITHIN A MAILING TUBE, fully protected for shipment.
6. One reproducible print of approved or disapproved shop drawings will be forwarded to Contractor.
7. When work is directly related and involves more than one trade, shop drawings shall be submitted to Architect-Engineer under one cover.

1-10. Samples shop drawings, test reports, certificates and manufacturers' literature and data, shall be submitted for approval to

____

(Architect-Engineer)

____

(A/E P.O. Address)

____

(City, State and Zip Code)

1-11. At the time of transmittal to the Architect-Engineer, the Contractor shall also send a copy of the complete submittal directly to the Resident Engineer.

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SECTION 01 42 19
REFERENCE STANDARDS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the availability and source of references and standards specified in the project manual under paragraphs APPLICABLE PUBLICATIONS and/or shown on the drawings.

1.2 AVAILABILITY OF SPECIFICATIONS LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS FPMR PART 101-29 (FAR 52.211-1) (AUG 1998)

A. The GSA Index of Federal Specifications, Standards and Commercial Item Descriptions, FPMR Part 101-29 and copies of specifications, standards, and commercial item descriptions cited in the solicitation may be obtained for a fee by submitting a request to – GSA Federal Supply Service, Specifications Section, Suite 8100, 470 East L'Enfant Plaza, SW, Washington, DC 20407, Telephone (202) 619-8925, Facsimile (202) 619-8978.

B. If the General Services Administration, Department of Agriculture, or Department of Veterans Affairs issued this solicitation, a single copy of specifications, standards, and commercial item descriptions cited in this solicitation may be obtained free of charge by submitting a request to the addressee in paragraph (a) of this provision. Additional copies will be issued for a fee.

1.3 AVAILABILITY FOR EXAMINATION OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-4) (JUN 1988)

The specifications and standards cited in this solicitation can be examined at the following location:

DEPARMENT OF VETERANS AFFAIRS
Office of Construction & Facilities Management
Facilities Quality Service (00CFM1A)
425 Eye Street N.W, (sixth floor)
Washington, DC 20001
Telephone Numbers: (202) 632-5249 or (202) 632-5178
Between 9:00 AM - 3:00 PM

1.4 AVAILABILITY OF SPECIFICATIONS NOT LISTED IN THE GSA INDEX OF FEDERAL SPECIFICATIONS, STANDARDS AND COMMERCIAL ITEM DESCRIPTIONS (FAR 52.211-3) (JUN 1988)

The specifications cited in this solicitation may be obtained from the associations or organizations listed below.

AA Aluminum Association Inc.
http://www.aluminum.org

AABC Associated Air Balance Council
http://www.aabchq.com

AAMA American Architectural Manufacturer's Association
http://www.aamanet.org

ACGIH American Conference of Governmental Industrial Hygienists
http://www.acgih.org

ACI American Concrete Institute
http://www.aci-int.net

ACPA American Concrete Pipe Association
http://www.concrete-pipe.org

ACPPA American Concrete Pressure Pipe Association
http://www.acppa.org

ADC Air Diffusion Council
http://flexibleduct.org

AGA American Gas Association
http://www.aga.org

AGC Associated General Contractors of America
http://www.agc.org

AGMA American Gear Manufacturers Association, Inc.
http://www.agma.org

AHAM	Association of Home Appliance Manufacturers http://www.aham.org
AISC	American Institute of Steel Construction http://www.aisc.org
AISI	American Iron and Steel Institute http://www.steel.org
AITC	American Institute of Timber Construction http://www.aitc-glulam.org
AMCA	Air Movement and Control Association, Inc. http://www.amca.org
ANSI	American National Standards Institute, Inc. http://www.ansi.org
APA	The Engineered Wood Association http://www.apawood.org
ARI	Air-Conditioning and Refrigeration Institute http://www.ari.org
ASCE	American Society of Civil Engineers http://www.asce.org
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers http://www.ashrae.org
ASME	American Society of Mechanical Engineers http://www.asme.org
ASSE	American Society of Sanitary Engineering http://www.asse-plumbing.org

ASTM	American Society for Testing and Materials http://www.astm.org
AWS	American Welding Society http://www.aws.org
AWWA	American Water Works Association http://www.awwa.org
BHMA	Builders Hardware Manufacturers Association http://www.buildershardware.com
CAGI	Compressed Air and Gas Institute http://www.cagi.org
CGA	Compressed Gas Association, Inc. http://www.cganet.com
CISCA	Ceilings and Interior Systems Construction Association http://www.cisca.org
CISPI	Cast Iron Soil Pipe Institute http://www.cispi.org
CPMB	Concrete Plant Manufacturers Bureau http://www.cpmb.org
CRSI	Concrete Reinforcing Steel Institute http://www.crsi.org
CTI	Cooling Technology Institute http://www.cti.org
DHI	Door and Hardware Institute http://www.dhi.org
EGSA	Electrical Generating Systems Association http://www.egsa.org

EEI	Edison Electric Institute http://www.eei.org
EPA	Environmental Protection Agency http://www.epa.gov
ETL	ETL Testing Laboratories, Inc. http://www.et1.com
GANA	Glass Association of North America http://www.cssinfo.com/info/gana.html/
FM	Factory Mutual Insurance http://www.fmglobal.com
GA	Gypsum Association http://www.gypsum.org
GSA	General Services Administration http://www.gsa.gov
HI	Hydraulic Institute http://www.pumps.org
ICBO	International Conference of Building Officials http://www.icbo.org
ICEA	Insulated Cable Engineers Association Inc. http://www.icea.net
ICAC	Institute of Clean Air Companies http://www.icac.com
IEEE	Institute of Electrical and Electronics Engineers http://www.ieee.org\
IMSA	International Municipal Signal Association http://www.imsasafety.org

IPCEA Insulated Power Cable Engineers Association

NBMA Metal Buildings Manufacturers Association
http://www.mbma.com

MSS Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
http://www.mss-hq.com

NAAMM National Association of Architectural Metal Manufacturers
http://www.naamm.org

NAPHCC Plumbing-Heating-Cooling Contractors Association
http://www.phccweb.org.org

NBS National Bureau of Standards
See - NIST

NBBPVI National Board of Boiler and Pressure Vessel Inspectors
http://www.nationboard.org

NEC National Electric Code
See - NFPA National Fire Protection Association

NEMA National Electrical Manufacturers Association
http://www.nema.org

NFPA National Fire Protection Association
http://www.nfpa.org

NIST National Institute of Standards and Technology
http://www.nist.gov

NWWDA Window and Door Manufacturers Association
http://www.nwwda.org

OSHA Occupational Safety and Health Administration
Department of Labor
http://www.osha.gov

PCA	Portland Cement Association http://www.portcement.org
PCI	Precast Prestressed Concrete Institute http://www.pci.org
PPI	The Plastic Pipe Institute http://www.plasticpipe.org
PEI	Porcelain Enamel Institute, Inc. http://www.porcelainenamel.com
PTI	Post-Tensioning Institute http://www.post-tensioning.org
RFCI	The Resilient Floor Covering Institute http://www.rfci.com
RMA	Rubber Manufacturers Association, Inc. http://www.rma.org
SDI	Steel Door Institute http://www.steeldoor.org
IGMA	Insulating Glass Manufacturers Alliance http://www.igmaonline.org
SJI	Steel Joist Institute http://www.steeljoist.org
SMACNA	Sheet Metal and Air-Conditioning Contractors National Association, Inc. http://www.smacna.org
SSPC	The Society for Protective Coatings http://www.sspc.org

STI	Steel Tank Institute http://www.steeltank.com
SWI	Steel Window Institute http://www.steelwindows.com
TCNA	Tile Council of North America, Inc. http://www.tileusa.com
TEMA	Tubular Exchange Manufacturers Association http://www.tema.org
TPI	Truss Plate Institute, Inc. 583 D'Onofrio Drive; Suite 200 Madison, WI 53719 (608) 833-5900
UBC	The Uniform Building Code See ICBO
UL	Underwriters' Laboratories Incorporated http://www.ul.com
ULC	Underwriters' Laboratories of Canada http://www.ulc.ca

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SECTION 01 45 29
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 DESCRIPTION:

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 Concrete Institute (ACI):

506.4R-94 (R2004) .... Guide for the Evaluation of Shotcrete

C. American Society for Testing and Materials (ASTM):

A325-06..................................... Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A370-07..................................... Definitions for Mechanical Testing of Steel Products

A416/A416M-06 .... Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

A490-06..................................... Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

C31/C31M-06............................. Making and Curing Concrete Test Specimens in the Field

C33-03 .... Concrete Aggregates

C39/C39M-05............................. Compressive Strength of Cylindrical Concrete Specimens

C109/C109M-05......................... Compressive Strength of Hydraulic Cement Mortars

C138-07 .... Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

C140-07 .... Sampling and Testing Concrete Masonry Units and Related Units

C143/C143M-05......................... Slump of Hydraulic Cement Concrete

C172-07 .... Sampling Freshly Mixed Concrete

C173-07 .... Air Content of freshly Mixed Concrete by the Volumetric Method

C330-05 .... Lightweight Aggregates for Structural Concrete

C567-05 .... Density Structural Lightweight Concrete

C780-07 .... Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

C1019-08 .... Sampling and Testing Grout

C1064/C1064M-05..................... Freshly Mixed Portland Cement Concrete

C1077-06 .... Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

C1314-07 .... Compressive Strength of Masonry Prisms

D698-07 .... Laboratory Compaction Characteristics of Soil Using Standard Effort

D1143-07 .... Piles Under Static Axial Compressive Load

D1188-07 .... Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

D1556-07 .... Density and Unit Weight of Soil in Place by the Sand-Cone Method

D1557-07 .... Laboratory Compaction Characteristics of Soil Using Modified Effort

D2166-06 .... Unconfined Compressive Strength of Cohesive Soil

D2167-94(R2001) .... Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D2216-05 .... Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2922-05 .... Density of soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

D2974-07 .... Moisture, Ash, and Organic Matter of Peat and Other Organic Soils

D3666-(2002)............................. Minimum Requirements for Agencies Testing and Inspection Bituminous Paving Materials

D3740-07 .... Minimum Requirements for Agencies Engaged in the Testing and Inspecting Road and Paving Material

E94-04....................................... Radiographic Testing

E164-03..................................... Ultrasonic Contact Examination of Weldments

E329-07..................................... Agencies Engaged in Construction Inspection and/or Testing

E543-06..................................... Agencies Performing Non-Destructive Testing

E605-93(R2006) .... Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members

E709-(2001) .... Guide for Magnetic Particle Examination

E1155-96(R2008) .... Determining FF Floor Flatness and FL Floor Levelness Numbers

D. American Welding Society (AWS):

D1.1-07 .... Structural Welding Code-Steel

1.3 REQUIREMENTS:

A. 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.”

B. 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.

C. 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.

D. Verbal Reports: Give verbal notification to Resident Engineer immediately of any irregularity.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EARTHWORK:

A. General: The Testing Laboratory 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 observation of fill placement and compaction and field density testing in building areas and provide 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 D1557 Method D.
2. Make field density tests in accordance with the primary testing method following ASTM D2922 wherever possible. Field density tests utilizing ASTM D1556 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 185 m^2 (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^2 (2000 square feet) of overlaying building slab, but in no case fewer than three tests.

b. 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, 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 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^3 (50 cubic yards) or less of each concrete type, and at least three cylinders for 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^3 (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m^3 (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, 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. 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^3 (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.

3.3 REINFORCEMENT:

A. Review mill test reports furnished by Contractor.
B. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.
C. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.
D. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

3.4 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.
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.
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. Verify that correction of rejected welds are made in accordance with AWS D1.1.

i. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the 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. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to Resident Engineer.

3.5 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.

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.

B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:
   1. Adversely effect human health or welfare,
   2. Unfavorably alter ecological balances of importance to human life,
   3. Effect other species of importance to humankind, or;
   4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.

C. Definitions of Pollutants:
   1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
   2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
   3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
   4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
   5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
   6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, tin cans, and bones.
   7. Sanitary Wastes:
      a. Sewage: Domestic sanitary sewage and human and animal waste.
      b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2 QUALITY CONTROL

A. Establish and maintain quality control for the environmental protection of all items set forth herein.

B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

1.3 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. U.S. National Archives and Records Administration (NARA):
33 CFR 328...............................Definitions

1.4 SUBMITTALS

A. In accordance with Section, 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:

1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Project Engineer to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the Project Engineer and the Contracting Officer for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:

a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's proposed operations and the requirements imposed by those laws, regulations, and permits.

f. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.

g. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.

h. Permits, licenses, and the location of the solid waste disposal area.

i. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials. Include as part of an Erosion Control Plan approved by the District Office of the U.S. Soil Conservation Service and the Department of Veterans Affairs.

j. Environmental Monitoring Plans for the job site including land, water, air, and noise.
k. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.

B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

1.5 PROTECTION OF ENVIRONMENTAL RESOURCES

A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.

B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without permission from the Project Engineer. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted.

1. Work Area Limits: Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.
2. Protection of Landscape: Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
   a. Box and protect from damage existing trees and shrubs to remain on the construction site.
   b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
   c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.
3. Reduction of Exposure of Unprotected Erodible Soils: Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.

4. Temporary Protection of Disturbed Areas: Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
    a. Sediment Basins: Trap sediment from construction areas in temporary or permanent sediment basins that accommodate the runoff of a local storm. After each storm, pump the basins dry and remove the accumulated sediment. Control overflow/drainage with paved weirs or by vertical overflow pipes, draining from the surface.
    b. Reuse or conserve the collected topsoil sediment as directed by the Project Engineer.
    c. Institute effluent quality monitoring programs as required by federal, state, and local environmental agencies.
5. Erosion and Sedimentation Control Devices: The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features on the Environmental Protection Plan. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
6. Manage borrow areas on Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
7. Manage and control spoil areas on Government property to limit spoil to areas on the Environmental Protection Plan and prevent erosion of soil or sediment from entering nearby water courses or lakes.
8. Protect adjacent areas from despoilment by temporary excavations and embankments.
9. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.
10. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
11. Handle discarded materials other than those included in the solid waste category as directed by the Project Engineer.

C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.

1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.
2. Control movement of materials and equipment at stream crossings during construction to prevent violation of water pollution control standards of the federal, state, or local government.
3. Monitor water areas affected by construction.

D. Protection of Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.

E. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the State of California and Air Quality Management District and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.

1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.

F. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the Project Engineer. Maintain noise-produced work at or below the decibel levels and within the time periods specified.

1. Perform construction activities involving repetitive, high-level impact noise only between 8:00 a.m. and 6:00 p.m. unless otherwise permitted by local ordinance or the Project Engineer. Repetitive impact noise on the property shall not exceed the following dB limitations:

Time Duration of Impact Noise	Sound Level in dB

More than 12 minutes in any hour	70
Less than 30 seconds of any hour	85
Less than three minutes of any hour	80
Less than 12 minutes of any hour	75

2. Provide sound-deadening devices on equipment and take noise abatement measures that are necessary to comply with the requirements of this contract, consisting of, but not limited to, the following:
   a. Maintain maximum permissible construction equipment noise levels at 15 m (50 feet) (dBA):

EARTHMOVING		MATERIALS HANDLING	
FRONT LOADERS	75	CONCRETE MIXERS	75
BACKHOES	75	CONCRETE PUMPS	75
DOZERS	75	CRANES	75
TRACTORS	75	DERRICKS IMPACT	75
SCAPERS	80	PILE DRIVERS	95
GRADERS	75	JACK HAMMERS	75
TRUCKS	75	ROCK DRILLS	80
PAVERS, STATIONARY	80	PNEUMATIC TOOLS	80
PUMPS	75	BLASTING	Not allowed
GENERATORS	75	SAWS	75
COMPRESSORS	75	VIBRATORS	75

   b. Use shields or other physical barriers to restrict noise transmission.
   c. Provide soundproof housings or enclosures for noise-producing machinery.
   d. Use efficient silencers on equipment air intakes.
   e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
   f. Line hoppers and storage bins with sound deadening material.
   g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings,

take measurements at 900 to 1800 mm (3 to 6 feet) in front of any building face. Submit the recorded information to the Project Engineer noting any problems and the alternatives for mitigating actions.

G. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.

H. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the Project Engineer. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

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SECTION 01 58 16
TEMPORARY INTERIOR SIGNAGE

PART 1 GENERAL

DESCRIPTION

This section specifies temporary interior signs.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNS

A. Fabricate from 50 kg (110-pound) mat finish white paper.

B. Cut to 100 mm (4-inch) wide by 300 mm (12 inch) long size tag.

C. Punch 3 mm (1/8-inch) diameter hole centered on 100 mm (4-inch) dimension of tag. Edge of Hole spaced approximately 13 mm (1/2 inch) from one end on tag.

D. Reinforce hole on both sides with gummed cloth washer or other suitable material capable of preventing tie pulling through paper edge.

E. Ties: Steel wire 0.3 mm (0.0120-inch) thick, attach to tag with twist tie, leaving 150 mm (6-inch) long free ends.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install temporary signs attached to room door frame or room door knob, lever, or pull for doors on corridor openings.

B. Mark on signs with felt tip marker having approximately 3 mm (1/8-inch) wide stroke for clearly legible numbers or letters.

C. Identify room with numbers as designated on floor plans.

3.2 LOCATION

A. Install on doors that have room, corridor, and space numbers shown.

B. Doors that do not require signs are as follows:

1. Corridor barrier doors (cross-corridor) in corridor with same number.
2. Folding doors or partitions.
3. Toilet or bathroom doors within and between rooms.
4. Communicating doors in partitions between rooms with corridor entrance doors.
5. Closet doors within rooms.

C. Replace missing, damaged, or illegible signs.

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SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies the requirements for the management of non-hazardous building construction and demolition waste.

B. Waste disposal in landfills shall be minimized to the greatest extent possible. Of the inevitable waste that is generated, as much of the waste material as economically feasible shall be salvaged, recycled or reused.

C. Contractor shall use all reasonable means to divert construction and demolition waste from landfills and incinerators, and facilitate their salvage and recycle not limited to the following:

1. Waste Management Plan development and implementation
2. Techniques to minimize waste generation
3. Sorting and separating of waste materials
4. Salvage of existing materials and items for reuse or resale
5. Recycling of materials that cannot be reused or sold

D. At a minimum the following waste categories shall be diverted from landfills:

1. Soil
2. Inerts (eg, concrete, masonry and asphalt)
3. Clean dimensional wood and palette wood
4. Green waste (biodegradable landscaping materials)
5. Engineered wood products (plywood, particle board and I-joists, etc.)
6. Metal products (e.g., steel, wire, beverage containers, copper, etc.)
7. Cardboard, paper and packaging
8. Bitumen roofing materials
9. Plastics (eg, ABS, PVC)
10. Carpet and/or pad
11. Gypsum board
12. Insulation
13. Paint
14. Fluorescent lamps

1.2 RELATED WORK

A. Section 02 41 00, DEMOLITION

B. Section 01 00 00, GENERAL REQUIREMENTS

C. Lead Paint: Section 02 83 33.13, LEAD BASED PAINT REMOVAL AND DISPOSAL

1.3 QUALITY ASSURANCE

A. Contractor shall practice efficient waste management when sizing, cutting and installing building products. Processes shall be employed to ensure the generation of as little waste as possible. Construction /Demolition waste includes products of the following:
   1. Excess or unusable construction materials
   2. Packaging used for construction products
   3. Poor planning and/or layout
   4. Construction error
   5. Over ordering
   6. Weather damage
   7. Contamination
   8. Mishandling
   9. Breakage

B. Establish and maintain the management of non-hazardous building construction and demolition waste set forth herein. Conduct a site assessment to estimate the types of materials that will be generated by demolition and construction.

C. Contractor shall develop and implement procedures to reuse and recycle new materials to a minimum of 50 percent.

D. Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to recycling. Any revenues or savings obtained from salvage or recycling shall accrue to the contractor.

E. Contractor shall provide all demolition, removal and legal disposal of materials. Contractor shall ensure that facilities used for recycling, reuse and disposal shall be permitted for the intended use to the extent required by local, state, federal regulations. The Whole Building Design Guide website http://www.wbdg.org provides a Construction Waste Management Database that contains information on companies that haul, collect, and process recyclable debris from construction projects.

F. Contractor shall assign a specific area to facilitate separation of materials for reuse, salvage, recycling, and return. Such areas are to be kept neat and clean and clearly marked in order to avoid contamination or mixing of materials.

G. Contractor shall provide on-site instructions and supervision of separation, handling, salvaging, recycling, reuse and return methods to be used by all parties during waste generating stages.

H. Record on daily reports any problems in complying with laws, regulations and ordinances with corrective action taken.

1.4 TERMINOLOGY

A. Class III Landfill: A landfill that accepts non-hazardous resources such as household, commercial and industrial waste resulting from construction, remodeling, repair and demolition operations.

B. Clean: Untreated and unpainted; uncontaminated with adhesives, oils, solvents, mastics and like products.

C. Construction and Demolition Waste: Includes all non-hazardous resources resulting from construction, remodeling, alterations, repair and demolition operations.

D. Dismantle: The process of parting out a building in such a way as to preserve the usefulness of its materials and components.

E. Disposal: Acceptance of solid wastes at a legally operating facility for the purpose of land filling (includes Class III landfills and inert fills).

F. Inert Backfill Site: A location, other than inert fill or other disposal facility, to which inert materials are taken for the purpose of filling an excavation, shoring or other soil engineering operation.

G. Inert Fill: A facility that can legally accept inert waste, such as asphalt and concrete exclusively for the purpose of disposal.

H. Inert Solids/Inert Waste: Non-liquid solid resources including, but not limited to, soil and concrete that does not contain hazardous waste or soluble pollutants at concentrations in excess of water-quality objectives established by a regional water board, and does not contain significant quantities of decomposable solid resources.

I. Mixed Debris: Loads that include commingled recyclable and non-recyclable materials generated at the construction site.

J. Mixed Debris Recycling Facility: A solid resource processing facility that accepts loads of mixed construction and demolition debris for the purpose of recovering re-usable and recyclable materials and disposing non-recyclable materials.

K. Permitted Waste Hauler: A company that holds a valid permit to collect and transport solid wastes from individuals or businesses for the purpose of recycling or disposal.

L. Recycling: The process of sorting, cleansing, treating, and reconstituting materials for the purpose of using the altered form in the manufacture of a new product. Recycling does not include burning, incinerating or thermally destroying solid waste.

   1. On-site Recycling – Materials that are sorted and processed on site for use in an altered state in the work, i.e. concrete crushed for use as a sub-base in paving.
   2. Off-site Recycling – Materials hauled to a location and used in an altered form in the manufacture of new products.

M. Recycling Facility: An operation that can legally accept materials for the purpose of processing the materials into an altered form for the manufacture of new products. Depending on the types of materials accepted and operating procedures, a recycling facility may or may not be required to have a solid waste facilities permit or be regulated by the local enforcement agency.

N. Reuse: Materials that are recovered for use in the same form, on-site or off-site.

O. Return: To give back reusable items or unused products to vendors for credit.

P. Salvage: To remove waste materials from the site for resale or re-use by a third party.

Q. Source-Separated Materials: Materials that are sorted by type at the site for the purpose of reuse and recycling.

R. Solid Waste: Materials that have been designated as non-recyclable and are discarded for the purposes of disposal.

S. Transfer Station: A facility that can legally accept solid waste for the purpose of temporarily storing the materials for re-loading onto other trucks and transporting them to a landfill for disposal, or recovering some materials for re-use or recycling.

1.5 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish the following:

B. Prepare and submit to the Resident Engineer a written demolition debris management plan. The plan shall include, but not be limited to, the following information:

   1. Procedures to be used for debris management.
   2. Techniques to be used to minimize waste generation.
   3. Analysis of the estimated job site waste to be generated:
      a. List of each material and quantity to be salvaged, reused, recycled.
      b. List of each material and quantity proposed to be taken to a landfill.
   4. Detailed description of the Means/Methods to be used for material handling.
      a. On site: Material separation, storage, protection where applicable.
      b. Off site: Transportation means and destination. Include list of materials.
         1) Description of materials to be site-separated and self-hauled to designated facilities.
         2) Description of mixed materials to be collected by designated waste haulers and removed from the site.
      c. The names and locations of mixed debris reuse and recycling facilities or sites.
      d. The names and locations of trash disposal landfill facilities or sites.
      e. Documentation that the facilities or sites are approved to receive the materials.

C. Designated Manager responsible for instructing personnel, supervising, documenting and administer over meetings relevant to the Waste Management Plan.

D. Monthly summary of construction and demolition debris diversion and disposal, quantifying all materials generated at the work site and disposed of or diverted from disposal through recycling.

1.6 APPLICABLE PUBLICATIONS

A Publications listed below form a part of this specification to the extent referenced. Publications are referenced by the basic designation only. In the event that criteria requirements conflict, the most stringent requirements shall be met.

B. U.S. Green Building Council (USGBC):
LEED Green Building Rating System for New Construction

1.7 RECORDS

Maintain records to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. Records shall be kept in accordance with the LEED Reference Guide and LEED Template.

PART 2 - PRODUCTS

2.1 MATERIALS

A. List of each material and quantity to be salvaged, recycled, reused.

B. List of each material and quantity proposed to be taken to a landfill.

C. Material tracking data: Receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices, net total costs or savings.

PART 3 - EXECUTION

3.1 COLLECTION

A. Provide all necessary containers, bins and storage areas to facilitate effective waste management.

B. Clearly identify containers, bins and storage areas so that recyclable materials are separated from trash and can be transported to respective recycling facility for processing.

C. Hazardous wastes shall be separated, stored, disposed of according to local, state, federal regulations.

3.2 DISPOSAL

A. Contractor shall be responsible for transporting and disposing of materials that cannot be delivered to a source-separated or mixed materials recycling facility to a transfer station or disposal facility that can accept the materials in accordance with state and federal regulations.

B. Construction or demolition materials with no practical reuse or that cannot be salvaged or recycled shall be disposed of at a landfill or incinerator.

3.3 REPORT

A. With each application for progress payment, submit a summary of construction and demolition debris diversion and disposal including beginning and ending dates of period covered.

B. Quantify all materials diverted from landfill disposal through salvage or recycling during the period with the receiving parties, dates removed, transportation costs, weight tickets, manifests, invoices. Include the net total costs or savings for each salvaged or recycled material.

C. Quantify all materials disposed of during the period with the receiving parties, dates removed, transportation costs, weight tickets, tipping fees, manifests, invoices. Include the net total costs for each disposal.

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SECTION 01 81 11
SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

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).

1.2 OBJECTIVES

A. 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 mot contaminate or enter duct work prior to system startup and turn over.

1.3 RELATED DOCUMENTS

A. Section 01 74 19 CONSTRUCTION WASTE MANANGEMENT

B. 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 of Agriculture 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 is 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”: 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 chemical offgasses.

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. Alternative Transportation: Provide manufacturer’s cut sheets for all bike racks installed on site, including the total number of bicycle storage slots provided. Also, provide manufacturer’s cut sheets for any alternative-fuel refueling stations installed on site, including fueling capacity information for an 8-hour period.
2. Heat Island Effect:
    a. Roofing Materials: Submittals for roofing materials must include manufacturer’s cut sheets or product data highlighting the Solar Reflectance Index (SRI) of the material.
3. 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.
4. 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.
5. Process Water Use: Provide manufacturer’s cut sheets for all water-consuming commercial equipment (clothes washers, dishwashers, ice machines, etc.), highlighting water consumption performance. Include manufacturer’s cut sheets or product data for any cooling towers, highlighting water consumption estimates, water use reduction measures, and corrosion inhibitors.
6. 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).
7. 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.

8. 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.
9. Measurement and Verification Systems: Provide cut sheets and manufacturer's product data for all controls systems, highlighting electrical metering and trending capability components.
10. Salvaged or Reused Materials: Provide documentation that lists each salvaged or reused material, the source or vendor of the material, the purchase price, and the replacement cost if greater than the purchase price.
11. Recycled Content: Submittals for all materials with recycled content (excluding MEP systems equipment and components) must include the following documentation:
    st of each material or product, excluding cost of labor and equipment for installation
    a. 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
    b. 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.

14. 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.

15. 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.

16. 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.

17. 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.

18. Lighting Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all lighting controls systems components.

19. Thermal Comfort Controls: Provide manufacturer's cut sheets and shop drawing documentation highlighting all thermal comfort-control systems components.

20. Blended Cement: It is the intent of this specification to reduce CO_2 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

21. 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 Owner and Architect 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 Owner and Architect 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. Not more than 30 days after the Preconstruction Meeting, prepare and submit for the Architect and Owner'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 Architect 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. Minimum of 18 Construction photographs: Six photographs taken on three different occasions 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.

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.

1.6 QUALITY ASSURANCE

A. Preconstruction Meeting: After award of Contract and prior to the commencement of the Work, schedule and conduct meeting with Owner, Architect, 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 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. 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.

B. 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.

C. 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 410a.
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.

D. 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.

E. Salvaged or Reused materials: There shall be no substitutions for specified salvaged and reused materials and products.
   1. Salvaged materials: Use of salvaged materials reduces impacts of disposal and manufacturing of replacements.

F. 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. E 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:

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

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SECTION 01 91 00
GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section 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 23, and Division 26 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 23, and Division 26 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 Project 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 Project 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 Project Engineer.

B. In this structure, only two contract parties are recognized and communications on contractual issues are strictly limited to VA Project 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 Project 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 Project 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 Project 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 Project 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 Project Engineer to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or Project Engineer will issue an official directive to this effect.
4. All parties to the Commissioning Process shall be individually responsible for alerting the Project 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 Project 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 26 08 00, COMMISSIONING OF ELECTRICAL SYSTEMS

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.

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, Project 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. Facility exterior closure (Division 7 and Division 8)
   a. Roofs (Asphalt shingles, slate shingles, wood shingles, clay roof tiles, built-up bituminous, modified bituminous, EPDM, PVC, fluid-applied, sprayed polyurethane, flashing & sheet metal, metal roofing, roof specialties, and roof accessories)
   b. Louvers and Vents
   c. Sealants (Caulking, mechanical seals, and wind and vapor barriers)
2. HVAC (Division 23)
   a. Heating Hot Water Systems (Boilers, controls, instrumentation and gages, flues, heating water pumps and motors, Variable Speed Drives, mixing valves).
   b. Condensate Return Systems (Condensate receivers and transfer pumps, motors, controls, pump alternator, alarms and instrumentation, deaerators, boiler feed pumps and motors, safeties).
   c. Exhaust Fans (Fan, motor, Variable Speed Drives, controls and safeties).
   d. Steam System (Boilers, controls, gages and instrumentation, safety relief valves, combustion burners/fans/motors, fuel delivery pumps and motors, flues).
   e. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).
   f. HVAC Water Treatment Systems (Closed circuits – including shot feeders and final water analysis, open circuits – including water analysis, chemical/biocide tanks, injection piping, chemical/biocide pumps and motors, controls, water meter, and automatic blowdown).

g. Fuel Delivery and Storage Systems for Boilers and Standby Generators (Fuel level monitoring/controls/alarms, transfer pumps and motors, leak detection monitoring/alarms, and fill systems)

3. Electrical (Division 26)
   a. Utility Service Entrance Switchgear (Fuses and circuit breaker settings, metering, mimic diagram, gages, and controls).
   b. Standby Generator Systems (Automatic transfer switches, fuel delivery pumps and motors, battery charging and instrumentation, muffler and exhaust system, and vibration isolation).
   c. Generator Paralleling Switchboards (Automatic transfer switches, instrumentation, metering and gages, and controls).
   d. Generator Power Distribution Systems (Fuses and circuit breaker settings, metering, gages, and controls).
   e. Utility Power Unit Substations (Transformers and tap settings, fuses and circuit breaker settings, metering, gages, and controls).
   f. Generator Power Unit Substations (Transformers and tap settings, fuses and circuit breaker settings, metering, gages, and controls).
   g. Automatic Transfer Switches (Test with associated generator).
   h. Normal Power Distribution Systems (Grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
   i. Life Safety Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
   j. Critical Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
   k. Essential Equipment Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
   l. Lighting Controls (Control system hardware and software, scene settings, zone settings, occupancy sensor interface, and unoccupied cycle control).
   m. Uninterruptible Power Supply Systems and UPS Power Distribution Systems (Battery chargers, static and dynamic power generators – i.e. inverters, MG sets, metering and controls, system power displays, and distribution panel circuit breakers).

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. <u>Systems Functional Performance Test Procedures</u>: 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 will 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 a 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.
3. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot check.
4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
5. Commissioning Issues Log.
6. Listing of deferred and off season test(s) not performed, including the schedule for their completion.

I. 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.

J. 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.
7. 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.

B. 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.

C. 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.

D. Pre-Functional Checklists: The Commissioning Agent will submit Pre-Functional Checklists to be completed by the Contractor.

E. 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.

F. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the VA Project Engineer with copies to the Contractor and Architect.

G. 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.

H. 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.

I. 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 30 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 30 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 degree C (1.0 degree F) and a resolution of ± 0.1 degree C (0.2 degree F). Pressure sensors shall have an accuracy of ± 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.
         a) The Commissioning Agent will submit the full startup plan to the VA and Contractor for review. Final approval will be by the VA.
         b) 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, CO_2 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 Project 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. <u>Pre-testing, Testing, and Post-testing</u> – 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 Project Engineer. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the Project Engineer, prior to the execution of Systems Functional Performance Testing.
2. <u>Dynamic plotting</u> – 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.
4. The following tables indicate the points to be trended and alarmed by system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV = Change of Value. The Alarm Type indicates the alarm priority; C = Critical, P = Priority, and M = Maintenance. The Alarm Range column indicates when the point is considered in the alarm state. The Alarm Delay column indicates the length of time the point must remain in an alarm state before the alarm is recorded in the DDC. The intent is to allow minor, short-duration events to be corrected by the DDC system prior to recording an alarm.

Steam and Condensate Pumps Trending and Alarms							
Point	**Type**	**Trend Interval**	**Operational Trend Duration**	**Testing Trend Dura-tion**	**Alarm Type**	**Alarm Range**	**Alarm Delay**
Steam Flow (LB/HR)	AI	15 Minutes	12 hours	3 days	N/A		
Condensate Pump Run Hours	AI	15 Minutes	12 hours	3 days	N/A		
Water Meter (GPM)	AI	15 Minutes	12 hours	3 days	N/A		
Electric Meter (KW/H)	AI	15 Minutes	12 hours	3 days	N/A		
High Water Level Alarm	DI	COV	12 hours	3 days	C	True	5 Min
Condensate Pump Start/Stop	DO	COV	12 hours	3 days	P	Status <> Command	10 min

Steam Boiler System Trending and Alarms

Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 1 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2,3 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 2,3 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2,3 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
System Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 1 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 1 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 2,3 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 2,3 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 2,3 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2,3 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 2,3 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2,3 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Combustion Damper Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Condensate Recovery Pump Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Boiler 1 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

Steam Boiler System Trending and Alarms							
Point	**Type**	**Trend Interval**	**Operational Trend Duration**	**Testing Trend Duration**	**Alarm Type**	**Alarm Range**	**Alarm Delay**
Boiler 2,3 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Combustion Damper Command	DO	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

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 Project 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.

3.5 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 degrees C (54 degrees F), when the outside air temperature is above 12 degrees C (54 degrees F), temporarily change the lockout setpoint to be 2 degrees C (4 degrees 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.

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 Project 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 23, and Division 26 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 x 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 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:

This section specifies demolition of portions of the building, utilities, and other structures as shown.

1.2 RELATED WORK:

A. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION

B. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS

C. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS

D. Asbestos Removal: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT

E. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS

F. Construction Waste Management: Section 017419 CONSTRUCTION WASTE MANAGEMENT

G. 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 level 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. 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.
3. Keep fire lanes and 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 Project 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 Project 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. Remove portions of the structure, including all appurtenances related or connected thereto, as indicated on the drawings.

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 Project 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. 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.

D. 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 Project Engineer. When Utility lines are encountered that are not indicated on the drawings, the Project Engineer shall be notified prior to further work in that area.

3.2 CLEAN-UP:

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Project 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.

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SECTION 02 82 11
TRADITIONAL ASBESTOS ABATEMENT

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SECTION 02 82 11
CLASS I NEGATIVE PRESSURE ENCLOSURE ASBESTOS ABATEMENT SPECIFICATIONS

PART 1 – GENERAL

1.1 SUMMARY OF THE WORK

1.1.1 CONTRACT DOCUMENTS AND RELATED REQUIREMENTS

A. 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 discovers a conflict in the contract documents and/or requirements or codes, the conflict must be immediately brought to the 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 Asbestos Abatement Contractor. All costs incurred due to such action are also the responsibility of the Asbestos Abatement Contractor.

1.1.2 EXTENT OF WORK

A. Below is a brief description of presumed locations of asbestos containing materials to be abated. These locations 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 locations and 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.

B. Abatement shall include removal, clean-up, and disposal of ACMs, trace asbestos, and assumed ACM as identified within the asbestos survey available from the VA San Diego Healthcare Center, 3350 La Jolla Village Drive, San Diego, California.

C. Asbestos Inspection Summary – Asbestos Positive Materials:
The proper control procedures, setup, removal, cleanup, and disposal of the asbestos materials listed below relate directly to the project within the subject building.

Items anticipated to be impacted by the project include but not limited to:

1. Drywall and joint compound – 2500 square feet (to be field verified)
2. 12x12 Floor Tile and Mastic 1200 square feet (to be field verified)
3. Thermal System Insulation (pipe insulations) (to be field verified)
4. 2x4 Ceiling Tiles (contaminated by upper fire proofing) 5500 square feet (to be field verified)
5. Fireproofing material 5500 square feet (to be field verified)
6. Fire Blocking material (to be field verified)
7. Brown Duct seam caulking / mastic (to be field verified)
8. Cloth pipe wrapping (to be field verified)

Items that may be impacted by the project include but limited to:

1. Transite wall / window panels located within outdoor open space (assumed asbestos – to be field verified)
2. Exterior Wall plaster / stucco located within outdoor open space (assumed asbestos – to be field verified)

All estimates of asbestos materials and quantities listed above are merely an estimate and are to be verified by the abatement contractor through project documentation (cross referencing the plans, demolition plans, specifications, asbestos surveys) and project work area site review. Upon request, the Comprehensive Hazardous Materials Survey listing ACM, trace asbestos, and assumed ACM as identified within the asbestos survey report section dated 3/2015 as it relates to the stairwell project located at the VA San Diego Healthcare System can be provided. The Comprehensive Hazardous Materials Survey was completed by ENCORP, 16700 Valley View Ave. Suite 100, La Mirada, California. 90638.

D. Presence of Asbestos in the Interstitial Space: It is noted that friable asbestos is present in the first/second floor interstitial space; demolition of ACMs will potentially expose the Hospital to hazardous materials. Contractor shall install barriers, maintain environmental control measures to protect the Hospital occupants, and monitor the air quality at all times during construction to ensure that occupants are not exposed to hazardous materials.

1.1.3 RELATED WORK

A. Section 02 41 00, DEMOLITION
B. Section 07 84 00, FIRESTOPPING
C. Division 09, FINISHES

1.1.4 TASKS

The work tasks are summarized briefly as follows:

A. Pre-abatement activities including pre-abatement meeting(s), inspection(s), notifications, permits, submittal approvals, regulated area preparations, emergency procedures arrangements, and standard operating procedures for 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.

1.1.5 CONTRACTOR’S USE OF PREMISES

A. 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.
B. The Contractor shall use the existing facilities in the building strictly within the limits indicated in contract documents as well as the approved VA Design and Construction Procedures. VA Design and Construction Procedures 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. Building limitations as set forth by the general specification will apply.

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 estimated which are limited by the physical constraints imposed by occupancy of the buildings and accessibility to ACM. 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 newly discovered ACM and those prices shall be used for additional work required under the Contractor.

1.3 STOP ASBESTOS REMOVAL

A. If the Contracting Officer; their field representative; (the facility Safety Officer/Manager or their designee, or the VA Professional Industrial Hygienist/Certified Industrial Hygienist (VPIH/CIH) presents a verbal **Stop Asbestos Removal Order**, the Contractor/Personnel shall immediately stop all asbestos removal and maintain HEPA filtered negative pressure air flow in the containment and adequately wet any exposed ACM. If a verbal Stop Asbestos Removal Order is issued, the VA shall follow-up with a written order to the Contractor as soon as it is practicable. The Contractor shall not resume any asbestos removal activity until authorized to do so in writing by the VA Contracting Officer. A stop asbestos removal order may be issued at any time the VA Contracting Officer determines abatement conditions/activities are not within VA specification, regulatory requirements or that an imminent hazard exists to human health or the environment. 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 VPIH/CIH time. The occurrence of any of the following events shall be reported immediately by the Contractor's competent person to the VA Contracting Office or field representative using the most expeditious means (e.g., verbal or telephonic), followed up with written notification to the Contracting Officer as soon as practical. The Contractor shall immediately stop asbestos removal/disturbance activities and initiate fiber reduction activities:
   1. Airborne PCM analysis results equal to or greater than 0.01 f/cc outside a regulated area or > 0.05 f/cc inside a regulated area;
   2. Breach or break in regulated area containment barrier(s);
   3. Less than – 0.5 millibar (– 0.02 inch) WCG pressure in the regulated area;
   4. Serious injury/death at the site;
   5. Fire/safety emergency at the site;
   6. Respiratory protection system failure;
   7. Power failure or loss of wetting agent; or
   8. Any visible emissions observed outside the regulated area.

1.4 DEFINITIONS

1.4.1 GENERAL

A. 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.

1.4.2 GLOSSARY

Abatement - Procedures to control fiber release from asbestos-containing materials. Includes removal, encapsulation, enclosure, demolition, and renovation activities related to asbestos containing materials (ACM).

Aerosol - Solid or liquid particulate suspended in air.

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.

Aggressive method - Removal or disturbance of building material by sanding, abrading, grinding, or other method that breaks, crumbles, or disintegrates intact ACM.

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.

AHERA - Asbestos Hazard Emergency Response Act. Asbestos regulations for schools issued in 1987.

Aircell - Pipe or duct insulation made of corrugated cardboard which contains asbestos.

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 for personal samples and clearance air testing using Phase Contrast Microscopy

(PCM) analysis. NIOSH Method 7402 can be used when it is necessary to confirm fibers counted by PCM as being asbestos. The AHERA TEM analysis may be used for background, area samples and clearance samples when required by this specification, or at the discretion of the VPIH/CIH as appropriate.

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)

Amended water - Water to which a surfactant (wetting agent) has been added to increase the penetrating ability of the liquid.

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.

Asbestos Hazard Abatement Plan (AHAP) - Asbestos work procedures required to be submitted by the Contractor before work begins.

Asbestos-containing material(s) (ACM) - Any material containing more than one percent of asbestos.

Asbestos contaminated element(s) (ACE) - Building elements such as ceilings, walls, lights, or ductwork that are contaminated with asbestos.

Asbestos-containing waste (ACW) material - Asbestos-containing material or asbestos contaminated objects requiring disposal.

Asbestos Project Monitor – Some states require that any person conducting asbestos abatement clearance inspections and clearance air sampling be licensed as an asbestos project monitor.

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.

Authorized person - Any person authorized by the VA, the Contractor, or government agency and required by work duties to be present in regulated areas.

Authorized visitor - Any person approved by the VA; the Contractor; or any government agency representative having jurisdiction over the regulated area (e.g., OSHA, Federal and State EPA.

Barrier - Any surface the isolates the regulated area and inhibits fiber migration from the regulated area.

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.

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.

Primary Barrier – Plastic barriers placed over critical barriers and exposed directly to abatement work.

Secondary Barrier - Any additional plastic barriers used to isolate and provide protection from debris during abatement work.

Breathing zone - The hemisphere forward of the shoulders with a radius of about 150 - 225 mm (6 - 9 inches) from the worker's nose.

Bridging encapsulant - An encapsulant that forms a layer on the surface of the ACM.

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.

Bulk testing - The collection and analysis of suspect asbestos containing materials.

Certified Industrial Hygienist (CIH) - A person certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.

Class I asbestos work - Activities involving the removal of Thermal System Insulation (TSI) and surfacing ACM and Presumed Asbestos Containing Material (PACM).

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.

Clean room/Changing room - An uncontaminated room having facilities for the storage of employee's street clothing and uncontaminated materials and equipment.

Clearance sample - The final air sample taken after all asbestos work has been done and visually inspected; performed by the VA's professional industrial hygiene consultant/Certified Industrial Hygienist (VPIH/CIH).

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.

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.

Contractor's Professional Industrial Hygienist (CPIH/CIH) - The asbestos abatement Contractor's industrial hygienist. The industrial hygienist must meet the qualification requirements of a PIH and may be a certified industrial hygienist (CIH).

Count - Refers to the fiber count or the average number of fibers greater than five microns in length with a length-to-width (aspect) ratio of at least 3 to 1, per cubic centimeter of air.

Crawlspace – An area which can be found either in or adjacent to the work area. This area has limited access and egress and may contain asbestos materials.

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.

Demolition - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

VA Total – means a building or substantial part of the building is completely removed, torn or knocked down, bulldozed, flattened, or razed, including removal of building debris.

Disposal bag - Typically 0.15 mm (6-mil) thick sift-proof, dustproof, leak-tight 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.

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 1524 mm (60 inches) in length or width.

Drum - A rigid, impermeable container made of cardboard fiber, plastic, or metal which can be sealed in order to be sift-proof, dustproof, and leak-tight.

Employee exposure - The exposure to airborne asbestos that would occur if the employee were not wearing respiratory protection equipment.

Encapsulant - A material that surrounds or embeds asbestos fibers in an adhesive matrix and prevents the release of fibers.

Encapsulation - Treating ACM with an encapsulant.

Enclosure - The construction of an airtight, impermeable, permanent barrier around ACM to control the release of asbestos fibers from the material and also eliminate access to the material.

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.

Fiber - A particulate form of asbestos, 5 microns or longer, with a length to width (aspect) ratio of at least 3 to 1.

Fibers per cubic centimeter (f/cc) - Abbreviation for fibers per cubic centimeter, used to describe the level of asbestos fibers in air.

Filter - Media used in respirators, vacuums, or other machines to remove particulate from air.

Firestopping - Material used to close the open parts of a structure in order to prevent a fire from spreading.

Friable asbestos containing material - Any material containing more than one (1) percent or 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.

Glovebag - Not more than a 1500 x 1500 mm (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.

High efficiency particulate air (HEPA) filter – An ASHRAE MERV 17 filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

HEPA vacuum - Vacuum collection equipment equipped with a HEPA filter system capable of collecting and retaining asbestos fibers.

Homogeneous area - An area of surfacing, thermal system insulation or miscellaneous ACM that is uniform in color, texture and date of application.

HVAC - Heating, Ventilation and Air Conditioning

ICRA - Infection Control Risk Assessment

Industrial hygienist (IH) - 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).

Industrial hygienist technician (IH 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. Some states require that an industrial hygienist technician conducting asbestos abatement clearance inspection and clearance air sampling be licensed as an asbestos project monitor.

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.

Lockdown - Applying encapsulant, after a final visual inspection, on all abated surfaces at the conclusion of ACM removal prior to removal of critical barriers.

National Emission Standards for Hazardous Air Pollutants (NESHAP) - EPA's rule to control emissions of asbestos to the environment (40 CFR Part 61, Subpart M).

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.

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 column gauge inside the negative pressure enclosure.

Negative pressure respirator - A respirator in which the air pressure inside the facepiece is negative during inhalation relative to the air pressure outside the respirator facepiece.

Non-friable ACM - Material that contains more than 1 percent asbestos but cannot be crumbled, pulverized, or reduced to powder by hand pressure.

Organic vapor cartridge - The type of cartridge used on air purifying respirators to remove organic vapor hazardous air contaminants.

Outside air - The air outside buildings and structures, including, but not limited to, the air under a bridge or in an open ferry dock.

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.

Penetrating encapsulant - Encapsulant that is absorbed into the ACM matrix without leaving a surface layer.

Personal sampling/monitoring - Representative air samples obtained in the breathing zone for one or workers within the regulated area using a filter cassette and a calibrated air sampling pump to determine asbestos exposure.

Permissible exposure limit (PEL) - The level of exposure OSHA allows for an 8 hour time weighted average. For asbestos fibers, the eight (8) hour time weighted average PEL is 0.1 fibers per cubic centimeter (0.1 f/cc) of air and the 30-minute Excursion Limit is 1.0 fibers per cubic centimeter (1 f/cc).

Personal protective equipment (PPE) – equipment designed to protect user from injury and/or specific job hazard. Such equipment may include protective clothing, hard hats, safety glasses, and respirators.

Pipe tunnel – An area, typically located adjacent to mechanical spaces or boiler rooms in which the pipes servicing the heating system in the building are routed to allow the pipes to access heating elements. These areas may contain asbestos pipe insulation, asbestos fittings.

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.

Polyethylene sheeting - Strong plastic barrier material 4 to 0.15 mm (6-mil)s thick, semi-transparent, flame retardant per NFPA 241.

Positive/negative fit check - A method of verifying the seal of a facepiece respirator by temporarily occluding the filters and breathing in (inhaling) and then temporarily occluding the exhalation valve and breathing out (exhaling) while checking for inward or outward leakage of the respirator respectively.

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 (b).

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. The PIH may be either the VA’s PIH (VPIH) or Contractor’s PIH (CPIH/CIH).

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).

Assigned protection factor - A value assigned by OSHA/NIOSH to indicate the expected protection provided by each respirator class, when the respirator is properly selected and worn correctly. The number indicates the reduction of exposure level from outside to inside the respirator facepiece.

Qualitative fit test (QLFT) - A fit test using a challenge material that can be sensed by the wearer if leakage in the respirator occurs.

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.

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.

Regulated ACM (RACM) - Friable ACM; Category I non-friable ACM that has become friable; Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or; Category II non-friable 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.

Removal - All operations where ACM, PACM and/or RACM is taken out or stripped from structures or substrates, including demolition operations.

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.

Repair - Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM or PACM attached to structures or substrates.

Shower room - The portion of the PDF where personnel shower before leaving the regulated area.

Supplied air respirator (SAR) - A respiratory protection system that supplies minimum Grade D respirable air per ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989.

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.

Surfactant - A chemical added to water to decrease water's surface tension thus making it more penetrating into ACM.

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.

Transmission electron microscopy (TEM) - A microscopy method that can identify and count asbestos fibers.

VA Professional Industrial Hygienist (VPIH/CIH) – The Department of Veterans Affairs Professional Industrial Hygienist must meet the qualifications of a PIH, and may be a Certified Industrial Hygienist (CIH).

VA Representative - The VA official responsible for on-going project work.

Visible emissions - Any emissions, which are visually detectable without the aid of instruments, coming from ACM/PACM/RACM/ACS or ACM waste material.

Waste/Equipment decontamination facility (W/EDF) – The area in which equipment is decontaminated before removal from the regulated area.

Waste generator - Any owner or operator whose act or process produces asbestos-containing waste material.

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.

Wet cleaning - The process of thoroughly eliminating, by wet methods, any asbestos contamination from surfaces or objects.

1.4.3 REFERENCED STANDARDS ORGANIZATIONS

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. NEC National Electrical Code (by NFPA)

K. NEMA National Electrical Manufacturer's Association
2101 L Street, N.W.
Washington, DC 20037

L. NFPA National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
800-344-3555

M. NIOSH National Institutes for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226
513-533-8236

N. NIST National Institute for Standards and Technology
U. S. Department of Commerce
Gaithersburg, MD 20234
301-921-1000

O. OSHA Occupational Safety and Health Administration
U.S. Department of Labor
Government Printing Office
Washington, DC 20402

P. UL Underwriters Laboratories
333 Pfingsten Rd.
Northbrook, IL 60062
312-272-8800

1.5 APPLICABLE CODES AND REGULATIONS

1.5.1 GENERAL APPLICABILITY OF CODES, REGULATIONS, AND STANDARDS

A. 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.

B. 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.

C. 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.

1.5.2 ASBESTOS ABATEMENT CONTRACTOR RESPONSIBILITY

A. The Asbestos Abatement Contractor (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 asbestos abatement project. The Contractor is responsible for providing and maintaining training, accreditations, medical exams, medical records, personal protective equipment (PPE) including respiratory protection including respirator fit testing, as required by applicable federal, state and local regulations. The Contractor shall hold the VA and VPIH/CIH consultants harmless for any Contractor's 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/CIH, including all sampling/analytical costs to assure compliance with OSHA/EPA/State requirements related to failure to comply with the regulations applicable to the work.

B. OSHA Training: All AE and sub consultants' personnel, who perform construction type work (during survey, verification of existing conditions etc.) shall have valid OSHA training (10 hours for all AE workers). If AE hires subcontractor to perform any construction work, Requirements are 30 hours Superintendent and 10 hrs. for other workers. Submit all training certificates to VA for approval.

   Construction type work example: Plumbing Contractor to remove a piece of pipe at designated areas (one or two) on each floor for testing.

C. Infection Control Protection Procedures: All AE and sub consultants' personnel, who perform work deemed as construction type work (during survey, verification of existing conditions etc.) shall comply with VA Infection Control Risk Assessment guidelines (IRCAs) and infection control measures (to be provided by AE and approved by VA).

1.5.3 FEDERAL REQUIREMENTS

Federal requirements which govern 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 Subpart I - Personal Protective Equipment
   3. Title 29 CFR 1910.134 - Respiratory Protection
   4. Title 29 CFR 1926 - Construction Industry Standards
   5. Title 29 CFR 1910.1020 - Access to Employee Exposure and Medical Records
   6. Title 29 CFR 1910.1200 - Hazard Communication
   7. Title 29 CFR 1910 Subpart K - 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

1.5.4 STATE AND LOCAL REQUIREMENTS

A. The Contractor shall comply with, but shall not be limited to, the following local and state rules and regulations as they relate to asbestos removal:
   1. State of California, Department of Occupational Safety and Health - Regulations for Construction and Handling Asbestos
   2. EPA Regional Office
   3. Local Air Pollution Agency (SD-APCD)
   4. CAL-OSHA
   5. City of San Diego

B. If local requirements are more stringent than federal or state standards, the local standards are to be followed.

1.5.5 STANDARDS

A. Standards which govern asbestos abatement activities include, but are not limited to, the following:
   1. American National Standards Institute (ANSI) Z9.2-79 - Fundamentals Governing the Design and Operation of Local Exhaust Systems and ANSI Z88.2 - Practices for Respiratory Protection.
   2. Underwriters Laboratories (UL) 586-90 - UL Standard for Safety of HEPA Filter Units, 7th Edition.

B. Standards which govern encapsulation work include, but are not limited to the following:
   1. American Society for Testing and Materials (ASTM)

C. Standards which govern the fire and safety concerns in abatement work include, but are not limited to, the following:
   1. National Fire Protection Association (NFPA) 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations.
   2. NFPA 701 - Standard Methods for Fire Tests for Flame Resistant Textiles and Film.
   3. NFPA 101 - Life Safety Code

1.5.6 EPA GUIDANCE DOCUMENTS

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.

A. Guidance for Controlling ACM in Buildings (Purple Book) EPA 560/5-85-024
B. Asbestos Waste Management Guidance EPA 530-SW-85-007
C. A Guide to Respiratory Protection for the Asbestos Abatement Industry EPA-560-OPTS-86-001
D. Guide to Managing Asbestos in Place (Green Book) TS 799 20T July 1990

1.5.7 NOTICES

A. 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.
B. Copies of notifications shall be submitted to the VA for the facility's records in the same time frame notification are given to EPA, state, and local authorities.

1.5.8 PERMITS/LICENSES

A. 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.
B. Permits and licenses to remove, transport, and dispose asbestos, including but not limited to:
   1. State of California

2. EPA Regional Office
3. Local Air Pollution Agency (SD-APCD)
4. CAL-OSHA
5. City of San Diego

1.5.9 POSTING AND FILING OF REGULATIONS

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

1.5.10 VA RESPONSIBILITIES

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, calibration data 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.

1.5.11 EMERGENCY ACTION PLAN AND ARRANGEMENTS

A. An Emergency Action Plan shall be developed 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) and (b).
B. Emergency procedures shall be in written form and prominently posted in the clean room and equipment room of the decontamination unit. 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.
C. Emergency planning shall include written notification of police, fire, and emergency medical personnel of planned abatement activities; work schedule; layout of regulated area; and access to the regulated area, particularly barriers that may affect response capabilities.
D. 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.
E. Employees shall be trained in regulated area/site evacuation procedures in the event of workplace emergencies.
    1. 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.
    2. 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.
F. Telephone numbers of any/all emergency response personnel shall be prominently posted in the clean room, along with the location of the nearest telephone.
G. The Contractor shall provide verification of first aid/CPR training for personnel responsible for providing first aid/CPR. OSHA requires medical assistance within 3-4 minutes of a life-threatening injury/illness. Blood borne Pathogen training shall also be verified for those personnel required to provide first aid/CPR.

H. 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; power failure; negative pressure failure; and supplied air system failure. The Contractor shall detail procedures to be followed in the event of an incident assuring that asbestos abatement work is stopped and wetting is continued until correction of the problem.

1.5.12 PRE-CONSTRUCTION MEETING

Prior to commencing the work, the Contractor shall meet with the VA Certified Industrial Hygienist (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. Evidence that all federal, state, and local requirements have been met to conduct asbestos removal, including but not limited to the following agencies:
   1. State of California
   2. EPA Regional Office
   3. Local Air Pollution Agency (SDAPCD)
   4. CAL-OSHA
   5. City of San Diego

B. Proof of Contractor licensing.
C. Proof the Competent Person(s) is trained and accredited and approved for working in this State. Verification of the experience of the Competent Person(s) shall also be presented.
D. A list of all workers who will participate in the project, including experience and verification of training and accreditation.
E. 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.
F. Current medical written opinions for all personnel working on-site meeting the requirements of 29 CFR 1926.1101 (m).
G. Current fit-tests for all personnel wearing respirators on-site meeting the requirements of 29 CFR 1926.1101 (h) and Appendix C.
H. A copy of the Contractor's Asbestos Hazard Abatement Plan. 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. Decontamination area set-up/layout and decontamination procedures for employees;
   4. Abatement methods/procedures and equipment to be used;
   5. Personal protective equipment to be used;
I. At this meeting the Contractor shall provide all submittals as required.
J. Procedures for handling, packaging and disposal of asbestos waste.
K. Emergency Action Plan and Contingency Plan Procedures.
L. Signed statement by the abatement contractor performing the work will strictly adhere to and comply with the VA San Diego’s infectious control procedures, regulated space access procedures, and general work activities and construction procedures that are currently in place. A copy of all VA San Diego’s plans and procedures for this type of work will be attached to the contractors’ signed statement of compliance.

1.6 PROJECT COORDINATION

A, The following are the minimum administrative and supervisory personnel necessary for coordination of the work:

1.6.1 PERSONNEL

A. Administrative and supervisory personnel shall consist of a qualified Competent Person(s) 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 color 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 federal (and state as applicable) EPA and OSHA asbestos regulations in the past three (3) years; has adequate liability/occurrence insurance for asbestos work as required by the state; 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 within the past three (3) years; 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/CIH (CPIH/CIH) 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 or equivalent, 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 within the past three (3) years of similar size and complexity; has applicable medical and respiratory protection documentation; has certificate of training/current refresher and State accreditation/license.

All personnel should be in compliance with OSHA construction safety training as applicable and submit certification.

1.7 RESPIRATORY PROTECTION

1.7.1 GENERAL - RESPIRATORY PROTECTION PROGRAM

A. The Contractor shall develop and implement a written 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.Subpart I;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 RPP shall, at a minimum, contain the basic requirements found at 29 CFR 1910.134 (c)(1)(i - ix) - Respiratory Protection Program.

1.7.2 RESPIRATORY PROTECTION PROGRAM COORDINATOR

A. The Respiratory Protection Program Coordinator (RPPC) must be identified and shall have two (2) years' experience coordinating RPP of similar size and complexity. The RPPC must submit a signed statement attesting to the fact that the program meets the above requirements.

1.7.3 SELECTION AND USE OF RESPIRATORS

A. The procedure for the selection and use of respirators must be submitted to the VA as part of the Contractor's qualifications. The procedure must written clearly enough for workers to understand.
B. 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.

1.7.4 MINIMUM RESPIRATORY PROTECTION

A. At start up, 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.

1.7.5 MEDICAL WRITTEN OPINION

A. No employee shall be allowed to wear a respirator unless a physician or other licensed health care professional has provided a written determination they are medically qualified to wear the class of respirator to be used on the project while wearing whole body impermeable garments and subjected to heat or cold stress.

1.7.6 RESPIRATOR FIT TEST

A. 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. Quantitative fit tests shall be done for PAPRs which have been put into a motor/blower failure mode.

1.7.7 RESPIRATOR FIT CHECK

A. The Competent Person shall assure that the positive/negative pressure user seal check is done each time the respirator is donned by an employee. Head coverings must cover respirator head straps. Any situation that prevents an effective facepiece to face seal as evidenced by failure of a user seal check shall preclude that person from wearing a respirator inside the regulated area until resolution of the problem.

1.7.8 MAINTENANCE AND CARE OF RESPIRATORS

A. The Respiratory Protection Program Coordinator shall submit evidence and documentation showing compliance with 29 CFR 1910.134 (h) Maintenance and Care of Respirators.

1.7.9 SUPPLIED AIR SYSTEMS

A. If a supplied air system is used, the system shall meet all requirements of 29 CFR 1910.134 and the ANSI/Compressed Gas Association (CGA) Commodity Specification for Air current requirements for Type 1 - Grade D breathing air. Low pressure systems are not allowed to be used on asbestos abatement projects. Supplied Air respirator use shall be in accordance with EPA/NIOSH publication EPA-560-OPTS-86-001 "A Guide to Respiratory Protection for the Asbestos Abatement Industry". The competent person on site will be responsible for the supplied air system to ensure the safety of the worker.

1.8 WORKER PROTECTION

1.8.1 TRAINING OF ABATEMENT PERSONNEL

A. 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.

1.8.2 MEDICAL EXAMINATIONS

A. 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. A current physician's written opinion as required by 29 CFR 1926.1101 (m)(4) shall be provided for each person and shall include in the medical opinion the person has been evaluated for working in a heat and cold stress environment while wearing personal protective equipment (PPE) and is able to perform the work without risk of material health impairment.

1.8.3 REGULATED AREA ENTRY PROCEDURE

A. 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.

1.8.4 DECONTAMINATION PROCEDURE

The Competent Person shall require all personnel to adhere to following decontamination procedures whenever they leave the regulated area:

A. When exiting the regulated area, remove disposable coveralls, and ALL other clothes, disposable head coverings, and foot coverings or boots in the equipment room.
B. 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 inhaling asbestos fibers while showering. The following procedure is required as a minimum:
   1. Thoroughly wet body including hair and face. If using a PAPR hold blower above head to keep filters dry.
   2. 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.
   3. 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.
C. 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!)**
D. Shower and wash body completely with soap and water. Rinse thoroughly.
E. Rinse shower room walls and floor to drain prior to exiting.
F. Proceed from shower to clean room; dry off and change into street clothes or into new disposable work clothing.

1.8.5 REGULATED AREA REQUIREMENTS

A. The Competent Person shall meet all requirements of 29 CFR 1926.1101 (o) and assure that all requirements for 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

1.9.1 DESCRIPTION

A. Provide each regulated area with separate personnel decontamination facilities (PDF) and waste/equipment decontamination facilities (W/EDF). Ensure that the PDF are 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.

1.9.2 GENERAL REQUIREMENTS

A. All personnel entering or exiting a regulated area must go through the PDF and shall follow the requirements at 29 CFR 1926.1101 (j)(1) and these specifications. All waste, equipment and contaminated 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 0.15 mm (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 0.15 mm (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. Weight inner doorway 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 and reduce potential for non-authorized personnel entering the regulated area.

1.9.3 TEMPORARY FACILITIES TO THE PDF AND W/EDF

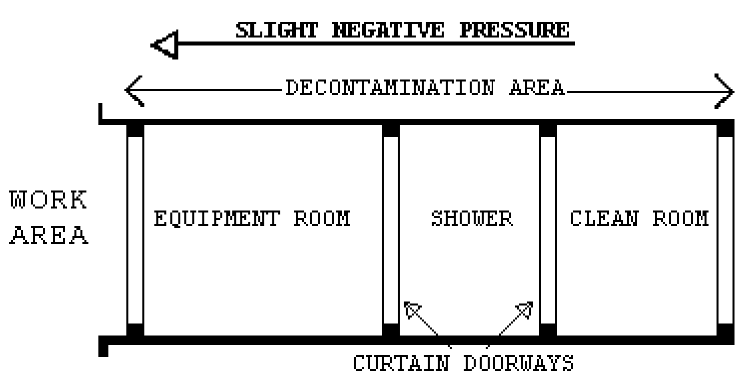
A. The Competent Person shall provide temporary water service connections to the PDF and W/EDF. Backflow prevention must be provided at the point of connection to the VA system. Water supply must be of adequate pressure and meet requirements of 29 CFR 1910.141(d)(3). Provide adequate temporary overhead electric power with ground fault circuit interruption (GFCI) protection. Provide a sub-panel equipped with GFCI protection 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, if needed, to maintain 70ºF throughout the PDF and W/EDF.

1.9.4 PERSONNEL DECONTAMINATION FACILITY (PDF)

A. The Competent Person shall provide a PDF consisting of shower room which is contiguous to a clean room and equipment room which is connected to the regulated area. 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.
   1. 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 3 layers of 0.15 mm (6-mil) opaque fire retardant poly to provide an airtight room. Provide a minimum of 2 - 900 mm (3 foot) wide 0.15 mm (6-mil) poly opaque fire retardant 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. Provide 1 storage locker per person. A portable fire extinguisher, minimum 10 pounds

capacity, 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.

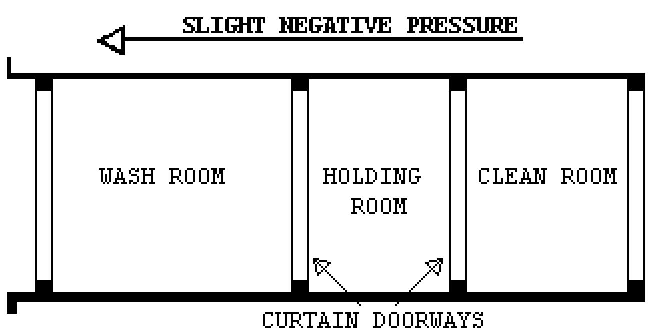
2. Shower Room: The Competent Person shall assure that the shower room is a completely water tight compartment to be used for the movement of all personnel from the clean room to the equipment room and for the showering of all personnel going from the equipment room to the clean room. Each shower shall 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 airtight walls made from at least 3 layers of 0.15 mm (6-mil) opaque 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.
3. Equipment Room: The Competent Person shall provide an equipment room which shall be an airtight compartment for the storage of work equipment/tools, reusable personal protective equipment, except for a respirator and for use as a gross decontamination area for personnel exiting the regulated area. The equipment room shall be separated from the regulated area by a minimum 3-foot wide door made with 2 layers of 0.15 mm (6-mil) opaque fire retardant poly. The equipment room shall be separated from the regulated area, the shower room and the rest of the building by airtight walls and ceiling constructed of a minimum of 3 layers of 0.15 mm (6-mil) opaque fire retardant poly. Damp wipe all surfaces of the equipment room after each shift change. Provide an additional loose layer of 0.15 mm (6-mil) fire retardant poly per shift change and remove this layer after each shift. If needed, provide a temporary electrical sub-panel equipped with GFCI in the equipment room to accommodate any equipment required in the regulated area.
4. The PDF shall be as follows: 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 shall be a minimum of 2 layers of 0.15 mm (6-mil) opaque fire retardant poly.



1.9.5 WASTE/EQUIPMENT DECONTAMINATION FACILITY (W/EDF)

A. The Competent Person shall provide a W/EDF consisting of a wash room, holding room, and clean room for removal of 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:

1. 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.
2. 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-inch) wood framing and 3 layers of 0.15 mm (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 0.15 mm (6-mil) fire retardant poly.
3. 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-inch) wood framing and 3 layers of 0.15 mm (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 0.15 mm (6-mil) fire retardant poly.
4. Clean Room: Provide a clean room to isolate the holding room from the exterior of the regulated area. Construct the clean room using 50 x 100 mm (2 x 4-inch) wood framing and 2 layers of 0.15 mm (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 2 layers of 6- mil fire retardant poly. When a negative pressure differential system is used, a rigid enclosure separation between the W/EDF clean room and the adjacent areas shall be provided.
5. The W/EDF shall be as follows: Wash Room leading to a Holding Room followed by a Clean Room leading to outside the regulated area. See diagram.



1.9.6 WASTE/EQUIPMENT DECONTAMINATION PROCEDURES

A. At the 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

2.1.1 GENERAL REQUIREMENTS

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/CIH has submitted verification to the VA's representative:

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 and combustible materials cannot be stored inside buildings. Replacement materials shall be stored outside of the regulated 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 location.
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. Polyethylene sheeting for walls in the regulated area shall be a minimum of 0.1 mm (4-mil). For floors and all other uses, sheeting of at least 0.15 mm (6-mil) shall be used in widths selected to minimize the frequency of joints. Fire retardant poly shall be used throughout.
F. 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. Method of attachment may include any combination of moisture resistant duct tape furring strips, spray glue, staples, nails, screws, lumber and plywood for enclosures or other effective procedures capable of sealing polyethylene to dissimilar finished or unfinished surfaces under both wet and dry conditions.
G. Polyethylene sheeting utilized for the PDF shall be opaque white or black in color, 0.15 mm (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, 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. All electrically operated hand tools, equipment, electric cords shall be connected to 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 0.15 mm (6-mil) poly 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 an advance copy of the MSDS as required for all hazardous chemicals under OSHA 29 CFR 1910.1200 - Hazard Communication in the pre-start meeting submittal. Chlorinated compounds shall not be used with any spray adhesive, mastic remover 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 written hazard assessment conducted under 29 CFR 1910.132(d).

2.2 MONITORING, INSPECTION, AND TESTING

2.2.1 GENERAL

A. Perform throughout abatement work monitoring, inspection and testing inside and around the regulated area in accordance with the OSHA requirements and these specifications. OSHA requires that the employee exposure to asbestos must not exceed 0.1 fiber per cubic centimeter (f/cc) of air, averaged over an 8-hour work shift. The CPIH/CIH is responsible for and shall 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/CIH 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.

B. Any on-site technician, industrial hygienist, certified industrial hygienist conducting any on-site monitoring, inspections, air sampling, and testing shall be certified through the State of California Division of Occupational Safety and Health (DOSH) as a Certified Asbestos Consultant (CAC) or a Site Surveillance Technician (SST) performing only approved activities under the direction of a CAC.

C. 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.

D. 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/CIH 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.

2.2.2 SCOPE OF SERVICES OF THE VPIH/CIH CONSULTANT

A. The purpose of the work of the VPIH/CIH is to: assure quality; adherence to the specification; resolve problems; prevent the spread of contamination beyond the regulated area; and assure clearance at the end of the project. 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. The VPIH/CIH will perform the following tasks:
   1. Task 1: Establish background levels before abatement begins by collecting background samples. Retain samples for possible TEM analysis.
   2. 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.

3. 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.
4. Task 4: Provide support to the VA representative such as evaluation of submittals from the Contractor, resolution of conflicts, interpret data, etc.
5. Task 5: Perform, in the presence of the VA representative, final inspection and testing of a decontaminated regulated area at the conclusion of the abatement to certify compliance with all regulations and VA requirements/specifications.
6. Task 6: Issue certificate of decontamination for each regulated area and project report.

B. 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.

C. 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.

2.2.3 MONITORING, INSPECTION, AND TESTING BY CONTRACTOR CPIH/CIH

A. The Contractor's CPIH/CIH 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/CIH 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 sampling and analysis. The IH Technician shall have successfully completed a NIOSH 582 Course or equivalent and provide documentation. 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 AHERA/State Contractor/Supervisor or Abatement Worker and Building Inspector. The IH Technician shall have participated in five abatement projects collecting personal and area samples as well as responsibility for documentation on substantially similar projects in size and scope. The analytic laboratory used by the Contractor to analyze the samples shall be AIHA accredited for asbestos PAT and approved by the VA prior to start of the project. A daily log shall be maintained by the CPIH/CIH or IH Technician, documenting all OSHA requirements for air personal 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 upon request. The log will contain, at a minimum, information on personnel or area samples, 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/CIH 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 93 m^2 (1,000 ft^2) 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/CIH will perform inspection and testing at the final stages of abatement for each regulated area as specified in the CPIH/CIH responsibilities. Additionally, the CPIH/CIH will monitor and record pressure readings within the containment daily with a minimum of two readings at the beginning and at the end of a shift, and submit the data in the daily report.

2.3 ASBESTOS HAZARD ABATEMENT PLAN

The Contractor shall prepare and have established an Asbestos Hazard Abatement Plan (AHAP) in printed form and loose leaf folder consisting of simplified text, diagrams, sketches, and pictures that establish and explain clearly the procedures to be followed during all phases of the work by the

Contractor's personnel. The AHAP must be modified as needed to address specific requirements of this project and the specifications. The AHAP shall be submitted for review and approval to the VA prior to the start of any abatement work. The minimum topics and areas to be covered by the AHAPs are:

A. Minimum Personnel Qualifications
B. Emergency Action Plan/Contingency Plans and Arrangements
C. Security and Safety Procedures
D. Respiratory Protection/Personal Protective Equipment Program and Training
E. Medical Surveillance Program and Recordkeeping
F. Regulated Area Requirements - Containment Barriers/Isolation of Regulated Area
G. Decontamination Facilities and Entry/Exit Procedures (PDF and W/EDF)
H. Negative Pressure Systems Requirements
I. Monitoring, Inspections, and Testing
J. Removal Procedures for ACM
K. Encapsulation Procedures for ACM
L. Disposal of ACM waste/equipment
M. Regulated Area Decontamination/Clean-up
N. Regulated Area Visual and Air Clearance
O. Project Completion/Closeout

2.4 SUBMITTALS

2.4.1 PRE-START MEETING SUBMITTALS

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 Asbestos Hazard Abatement Plan developed specifically for this project, incorporating the requirements of the specifications, prepared, signed and dated by the CPIH/CIH.
D. Submit the specifics of the materials and equipment to be used for this project with manufacturer names, model numbers, performance characteristics, pictures/diagrams, and number available for the following:
    1. Supplied air system, negative air machines, HEPA vacuums, air monitoring pumps, calibration devices, pressure differential monitoring device and emergency power generating system.
    2. Waste water filtration system, shower system, containment barriers.
    3. Encapsulants, surfactants, hand held sprayers, airless sprayers, glovebags, and fire extinguishers.
    4. Respirators, protective clothing, 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. Personal air monitoring must be done in accordance with

OSHA 29 CFR 1926.1101(f) and Appendix A. Area or clearance air monitoring shall be conducted in accordance with EPA AHERA protocols.

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 (e.g., OSHA), notices of violations (e.g., Federal and state EPA), penalties, and legal actions taken against the company including and of the company's officers (including damages paid) in the last 3 years. Provide copies and all information needed for verification.

I. Submit information on personnel: Provide a resume; address each item completely; copies of certificates, accreditations, and licenses. Submit an affidavit signed by the CPIH/CIH 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 written respiratory protection program, and maintains recordkeeping in accordance with the above regulations. Submit the phone number and doctor/clinic/hospital used for medical evaluations.
   1. CPIH/CIH and IH Technician: 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 AHAPs developed; medical opinion; and current respirator fit test.
   2. Competent Person(s)/Supervisor(s): Number; names; social security numbers; years of abatement experience as Competent Person/Supervisor; list of similar projects in size/complexity 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 (asbestos surveillance and respirator use); and current respirator fit test.
   3. Workers: Numbers; names; social security numbers; years of abatement experience; certificates, licenses, accreditations; training courses in asbestos abatement and respiratory protection; medical opinion (asbestos surveillance and respirator use); and current respirator fit test.

J. Submit copies of state license for asbestos abatement; copy of insurance policy, including exclusions with a letter from agent stating in plain language the coverage provided and the fact that asbestos abatement activities are covered by the policy; copy of AHAPs incorporating the requirements of this specification; information on who provides your training, how often; who provides medical surveillance, how often; who performs and how is personal air monitoring of abatement workers conducted; a list of references of independent laboratories/IH's familiar with your air monitoring and standard operating procedures; and copies of monitoring results of the five referenced projects listed and analytical method(s) used.

K. Rented equipment must be decontaminated prior to returning to the rental agency.

L. Submit, before the start of work, the manufacturer's technical data for all types of encapsulants, all MSDS and application instructions.

2.4.2 SUBMITTALS DURING ABATEMENT

A. 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 barrier breeching, equipment failures, emergencies, and any cause for stopping work; and representative air monitoring and results/TWA's/EL's. Submit this information daily to the VPIH/CIH.

B. The CPIH/CIH shall document and maintain the inspection and approval of the regulated area preparation prior to start of work and daily during work.

1. Removal of any poly barriers.
2. Visual inspection/testing by the CPIH/CIH or IH Technician prior to application of lockdown encapsulant.
3. Packaging and removal of ACM waste from regulated area.
4. Disposal of ACM waste materials; copies of Waste Shipment Records/landfill receipts to the VA's representative on a weekly basis.

2.4.3 SUBMITTALS AT COMPLETION OF ABATEMENT

A. The CPIH/CIH 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. It will also include information on the containment and transportation of waste from the containment with applicable Chain of Custody forms. The report shall include a certificate of completion, signed and dated by the CPIH/CIH, in accordance with Attachment #1. All clearance and perimeter area samples must be submitted. The VA Representative will retain the abatement report after completion of the project and provide copies of the abatement report to VAMC Office of Engineer and the Safety Office.

2.5 ENCAPSULANTS

2.5.1 TYPES OF ENCAPSULANTS

A. The following four types of encapsulants, if used, must comply with comply with performance requirements as stated in paragraph 2.5.2:
   1. Removal encapsulant - used as a wetting agent to remove ACM.
   2. Bridging encapsulant - provides a tough, durable coating on ACM.
   3. Penetrating encapsulant - penetrates/encapsulates ACM at least 13 mm (1/2 inch).
   4. Lockdown encapsulant - seals microscopic fibers on surfaces after ACM removal.

2.5.2 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:

A. General Requirements for all Encapsulants:
   1. ASTM E84: Flame spread of 25; smoke emission of 50
   2. University of Pittsburgh Protocol: Combustion Toxicity; zero mortality
   3. ASTM C732: Accelerated Aging Test; Life Expectancy - 20 years
   4. ASTM E96: Permeability - minimum of 0.4 perms
B. Bridging/Penetrating Encapsulants:
   1. ASTM E736: Cohesion/Adhesion Test - 24 kPa (50 lbs/ft^2)
   2. ASTM E119: Fire Resistance - 3 hours (Classified by UL for use on fibrous/cementitious fireproofing).
   3. ASTM D2794: Gardner Impact Test; Impact Resistance - minimum 11.5 kg-mm (43 in/lb)
   4. ASTM D522: Mandrel Bend Test; Flexibility - no rupture or cracking
C. Lockdown Encapsulants:
   1. ASTM E119: Fire resistance - 3 hours (tested with fireproofing over encapsulant applied directly to steel member).
   2. ASTM E736: Bond Strength - 48 kPa (100 lbs/ft^2) (test compatibility with cementitious and fibrous fireproofing).
   3. 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.

2.5.3 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.

PART 3 - EXECUTION

3.1 REGULATED AREA PREPARATIONS

3.1.1 SITE SECURITY

A. 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.
B. 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 require any unauthorized person to leave the regulated area and then notify the VA Contracting Officer or VA Representative using the most expeditious means.
C. 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.
D. Access to the regulated area shall be through a single decontamination unit. 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. In any situation where exposure to high temperatures which may result in a flame hazard, fire retardant poly sheeting must be used.
E. 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.
F. 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.
G. The regulated area shall be locked during non-working hours and secured by VA Representative or Competent Person. The VA Police should be informed of asbestos abatement regulated areas to provide security checks during facility rounds and emergency response.

3.1.2 SIGNAGE AND POWER MANAGEMENT

A. 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 the PEL. 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 and lock out/tag 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 and OSHA requirements for temporary electrical systems. Electricity shall be provided by the VA.
C. Shut down and lock out/tag 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 0.15 mm (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 0.15 mm (6-mil) polyethylene disposal bags for staging and eventual disposal as asbestos waste.

3.1.3 NEGATIVE PRESSURE FILTRATION SYSTEM

A. The Contractor shall provide enough HEPA negative air machines to effect > - 0.5 millibar (- 0.02 inch) WCG pressure. The Competent Person shall determine the number of units needed for the regulated area by dividing the cubic feet in the regulated area by 15 and then dividing that result by the cubic feet per minute (CFM) for each unit to determine the number of units needed to effect > - 0.5 mm (- 0.02 inch) WCG pressure. Provide a standby unit in the event of machine failure and/or emergency in an adjacent area.

B. NIOSH has done extensive studies and has determined that negative air machines typically operate at ~50% efficiency. The Contractor shall consider this in their determination of number of units needed to provide > -0.5 mm (- 0.02 inch) WCG pressure. The Contractor shall use double the number of machines, based on their calculations, or submit proof their machines operate at stated capacities, at a 50.8 mm (2-inch) pressure drop across the filters.

C. Design and Layout:

   1. Before start of work submit the design and layout of the regulated area and the negative air machines. The submittal shall indicate the number of, location of and size of negative air machines. The point(s) of exhaust, air flow within the regulated area, anticipated negative pressure differential, and supporting calculations for sizing shall be provided. In addition, submit the following:

      a) Method of supplying power to the units and designation/location of the panels.

      b) Description of testing method(s) for correct air volume and pressure differential.

      c) If auxiliary power supply is to be provided for the negative air machines, provide a schematic diagram of the power supply and manufacturer's data on the generator and switch.

D. Negative Air Machines (HEPA Units):

   1. Negative Air Machine Cabinet: The cabinet shall be constructed of steel or other durable material capable of withstanding potential damage from rough handling and transportation. The width of the cabinet shall be less than 762 mm (30 inches) in order to fit in standard doorways. The cabinet must be factory sealed to prevent asbestos fibers from being released during use, transport, or maintenance. Any access to and replacement of filters shall be from the inlet end. The unit must be on casters or wheels.

   2. Negative Air Machine Fan: The rating capacity of the fan must indicate the CFM under actual operating conditions. Manufacturer's typically use "free-air" (no resistance) conditions when rating fans. The fan must be a centrifugal type fan.

   3. Negative Air Machine Final Filter: The final filter shall be a HEPA filter. The filter media must be completely sealed on all edges within a structurally rigid frame. The filter shall align with a continuous flexible gasket material in the negative air machine housing to form an airtight seal. Each HEPA filter shall be certified by the manufacturer to have an efficiency of not less than 99.97%. Testing shall have been done in accordance with Military Standard MIL-STD-282 and Army Instruction Manual 136-300-175A. Each filter must bear a UL586 label to indicate ability to perform under specified conditions. Each filter shall be marked with the name of the manufacturer, serial number, air flow rating, efficiency and resistance, and the direction of test air flow.

   4. Negative Air Machine Pre-filters: The pre-filters, which protect the final HEPA filter by removing larger particles, are required to prolong the operating life of the HEPA filter. Two stages of pre-filtration are required. A first stage pre-filter shall be a low efficiency type for particles 10 µm or larger. A second stage pre-filter shall have a medium efficiency effective for particles down to 5 µm or larger. Pre-filters shall be installed either on or in the intake opening of the NAM and the second stage filter must be held in place with a special housing or clamps.

   5. Negative Air Machine Instrumentation: Each unit must be equipped with a gauge to measure the pressure drop across the filters and to indicate when filters have become loaded and

need to be changed. A table indicating the cfm for various pressure readings on the gauge shall be affixed near the gauge for reference or the reading shall indicate at what point the filters shall be changed, noting cfm delivery. The unit must have an elapsed time meter to show total hours of operation.

6. Negative Air Machine Safety and Warning Devices: An electrical/ mechanical lockout must be provided to prevent the fan from being operated without a HEPA filter. Units must be equipped with an automatic shutdown device to stop the fan in the event of a rupture in the HEPA filter or blockage in the discharge of the fan. Warning lights are required to indicate normal operation; too high a pressure drop across filters; or too low of a pressure drop across filters.
7. Negative Air Machine Electrical: All electrical components shall be approved by the National Electrical Manufacturer's Association (NEMA) and Underwriters Laboratories (UL). Each unit must be provided with overload protection and the motor, fan, fan housing, and cabinet must be grounded.
8. It is essential that replacement HEPA filters be tested using an “in-line” testing method, to ensure the seal around the periphery was not damaged during replacement. Damage to the outer HEPA filter seal could allow contaminated air to bypass the HEPA filter and be discharged to an inappropriate location. Contractor will provide written documentation of test results for negative air machine units with HEPA filters changed by the Contractor or documentation when changed and tested by the Contractor filters

E. Pressure Differential:
   1. The fully operational negative air system within the regulated area shall continuously maintain a pressure differential of - 0.5 mm (- 0.02 inch) water column gauge. Before any disturbance of any asbestos material, this shall be demonstrated to the VA by use of a pressure differential meter/manometer as required by OSHA 29 CFR 1926.1101(e)(5)(i). The Competent Person shall be responsible for providing, maintaining, and documenting the negative pressure and air changes as required by OSHA and this specification.

F. Monitoring:
   1. The pressure differential shall be continuously monitored and recorded between the regulated area and the area outside the regulated area with a monitoring device that incorporates a strip chart recorder. The strip chart recorder shall become part of the project log and shall indicate at least -0.02" water column gauge for the duration of the project.

G. Auxiliary Generator:
   1. If the building is occupied during abatement, provide an auxiliary gasoline/diesel generator located outside the building in an area protected from the weather. In the event of a power failure of the general power grid and the VAMC emergency power grid, the generator must automatically start and supply power to a minimum of 50% of the negative air machines in operation.

H. Supplemental Make-Up Air Inlets:
   1. Provide, as needed for proper air flow in the regulated area, in a location approved by the VA, openings in the plastic sheeting to allow outside air to flow into the regulated area. Auxiliary makeup air inlets must be located as far from the negative air machines as possible, off the floor near the ceiling, and away from the barriers that separate the regulated area from the occupied clean areas. Cover the inlets with weighted flaps which will seal in the event of failure of the negative pressure system.

I. Testing the System:
   1. The negative pressure system must be tested before any ACM is disturbed in any way. After the regulated area has been completely prepared, the decontamination units set up, and the negative air machines installed, start the units up one at a time. Demonstrate and document the operation and testing of the negative pressure system to the VA using smoke tubes and a negative pressure gauge. Verification and documentation of adequate negative pressure differential across each barrier must be done at the start of each work shift.

J. Demonstration of the Negative Pressure Filtration System:

   The demonstration of the operation of the negative pressure system to the VA shall include, but not be limited to, the following:
   1. Plastic barriers and sheeting move lightly in toward the regulated area.

2. Curtains of the decontamination units move in toward regulated area.
3. There is a noticeable movement of air through the decontamination units. Use the smoke tube to demonstrate air movement from the clean room to the shower room to the equipment room to the regulated area.
4. Use smoke tubes to demonstrate air is moving across all areas in which work is to be done. Use a differential pressure gauge to indicate a negative pressure of at least -0.02" across every barrier separating the regulated area from the rest of the building. Modify the system as necessary to meet the above requirements.

K. Use of the Negative Pressure Filtration System during Abatement Operations:
1. Start units before beginning any disturbance of ACM occurs. After work begins, the units shall run continuously, maintaining 4 actual air changes per hour at a negative pressure differential of – 0.5 mm (- 0.02 inch) water column gauge, for the duration of the work until a final visual clearance and final air clearance has been successfully completed.
2. No negative air units shall be shut down at any time unless authorized by the VA Contracting Officer, verbally and in writing.
3. Pre-cleaning of ACM contaminated items shall be performed after the enclosure has been erected and negative pressure has been established in the work area. After items have been pre-cleaned and decontaminated, they may be removed from the work area for storage until the completion of abatement in the work area.
4. Abatement work shall begin at a location farthest from the units and proceed towards them. If an electric failure occurs, the Competent Person shall stop all abatement work and immediately begin wetting all exposed asbestos materials for the duration of the power outage. Abatement work shall not resume until power is restored and all units are operating properly again.
5. The negative air machines shall continue to run after all work is completed and until a final visual clearance and a final air clearance has been successfully completed for that regulated area.

L. Dismantling the System:
1. After completion of the final visual and final air clearance has been obtained by the VPIH/CIH, the units may be shut down. The unit exterior surfaces shall have been completely decontaminated; pre-filters are not to be removed and the units' inlet/outlet sealed with 2 layers of 0.15 mm (6-mil) poly immediately after shut down. No filter removal shall occur at the VA site following successful completion of site clearance. OSHA/EPA/DOT asbestos shall be attached to the units.

3.1.4 CONTAINMENT BARRIERS AND COVERINGS IN THE REGULATED AREA

A. General:
1. Seal off the perimeter to the regulated area to completely isolate the regulated area from adjacent spaces. All surfaces in the regulated area must be covered to prevent contamination and to facilitate clean-up. Should adjacent areas become contaminated as a result of the work, shall immediately stop work and clean up the contamination at no additional cost to the VA. Provide firestopping and identify all fire barrier penetrations due to abatement work as specified in Article 3.1.4, Paragraph H; 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. All uncontaminated removable furniture, equipment and/or supplies shall be removed by the VA from the regulated area before commencing work. Any objects remaining in the regulated area shall be completely covered with 2 layers of 0.15 mm (6-mil) fire retardant poly sheeting and secured with duct tape. Lock out and tag out any HVAC/electrical 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). 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 0.15 mm (6-mil) opaque fire retardant poly to

prevent building occupant observation. If the adjacent area is accessible to the public, the barrier must be solid and capable of withstanding the negative pressure.

D. Critical Barriers:
1. Completely separate any operations in the regulated area from adjacent areas using 2 layers of 0.15 mm (6-mil) fire retardant poly and duct tape. Individually seal with 2 layers of 0.15 mm (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/openings in the regulated area. Heat must be shut off any objects covered with poly.

E. Primary Barriers:
1. Cover the regulated area with two layers of 0.15 mm (6-mil) fire retardant poly on non-affected floors and two layers of 0.10 mm (4-mil), fire retardant poly on the walls, unless otherwise directed in writing by the VA representative. Floor layers must form a right angle with the wall and turn up the wall at least 300 mm (12 inches). Seams must overlap at least 1800 mm (6 feet) and must be spray glued and taped. Install sheeting so that layers can be removed independently from each other. Carpeting shall be covered with three layers of 0.15 mm (6-mil) poly. Corrugated cardboard sheets must be placed between the bottom and middle layers of poly. Mechanically support and seal with duct tape and glue all wall layers.
2. Reference the Comprehensive Hazardous Materials Survey for a list of ACM, trace asbestos, and assumed ACM as identified within the asbestos survey report section dated 3/2015 as it relates to the stairwell project located at the VA San Diego Healthcare System. The Comprehensive Hazardous Materials Survey was completed by ENCORP, 16700 Valley View Ave. Suite 100, La Mirada, California. 90638. Cross reference the asbestos sampling report with the proposed building demolition plan, diagrams and drawings.
3. The removal, cleanup, and disposal of the asbestos materials listed below relate directly to the asbestos containing materials as identified within the subject building. The set-up / preparation work completed by the asbestos removal Contractor will take into account that all walls and ceilings that are not part of the actual asbestos removal will be protected. The asbestos removal Contractor will submit a detailed set-up / preparation work space submittal and diagram to be pre-approved prior to commencement of any asbestos removal activities.
4. If stairs and ramps are covered with 0.15 mm (6-mil) plastic, two layers must be used. Provide 19 mm (3/4 inch) exterior grade plywood treads held in place with duct tape/glue on the plastic. Do not cover rungs or rails with any isolation materials.

F. Secondary Barriers:
1. A loose layer of 0.15 mm (6-mil) polyethylene sheeting shall be used as a drop cloth to protect the primary layers from debris generated during the abatement. This layer shall be replaced as needed during the work and at a minimum once per work day.

G. 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. Decontamination measures must be started immediately and continue until air monitoring indicates background levels are met.

H. Firestopping:
1. Through penetrations caused by cables, cable trays, pipes, sleeves, conduits, etc. must be firestopped with a fire-rated firestop system providing an airtight 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.

3.1.5 SANITARY FACILITIES

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

3.1.6 PERSONAL PROTECTIVE EQUIPMENT

A. Provide whole body clothing, head coverings, gloves and 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.

3.1.7 PRE-CLEANING

A. 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.
B. Pre-cleaning of ACM contaminated items shall be performed after the enclosure has been erected and negative pressure has been established in the work area. All workers performing pre-cleaning activities must don appropriate personal protective equipment (PPE), as specified throughout this document and as approved in the Contractor’s work plan. After items have been pre-cleaned and decontaminated, they may be removed from the work area for storage until the completion of abatement in the work area.
C. 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. If ACM floor tile is attached to the carpet while the Contractor is removing the carpet that section of the carpet will be disposed of as asbestos waste.
D. 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 grilles 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 pre-cleaning, enclose fixed objects with 2 layers of 0.15 mm (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. To be completed by the Asbestos Removal Contractor.
E. 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.

3.1.8 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/CIH 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/CIH, 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 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/CIH 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 AHAP(s), especially worker protection, respiratory systems, contingency plans, decontamination procedures, and monitoring to demonstrate satisfactory operation. The operational systems for respiratory protection and the negative pressure system shall be demonstrated for proper performance.
3. The CPIH/CIH 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 and all applicable regulations.

C. 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 VA A/E Quality Alert 07/09 indicating the failure to identify asbestos in the areas listed as well as common issues when preparing specifications and contract documents. This is especially critical when demolition is planned, because AHERA surveys are non-destructive, and ACM may remain undetected. A NESHAPS (destructive) ACM inspection should be conducted on all building structures that will be demolished. Ensure the following areas are inspected on the project: lay-in ceilings concealing ACM; ACM behind walls/windows from previous renovations; inside utility chases/walls; transite piping/ductwork/sheets; behind radiators; lab fume hoods; transite lab countertops; roofing materials; below window sills; water/sewer lines; electrical conduit coverings; crawlspaces (previous abatement contamination); flooring/mastic covered by carpeting/new flooring; exterior insulated wall panels; on underground fuel tanks; and steam line trench coverings.
3. Ensure that all furniture, machinery, equipment, curtains, drapes, blinds, and other movable objects required to be removed from the regulated area have been cleaned and removed or properly protected from contamination.
4. If present and required, remove and dispose of carpeting from floors in the regulated area.
5. Inspect existing firestopping in the regulated area. Correct as needed.

3.2 REMOVAL OF ACM

3.2.1 WETTING ACM

A. 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 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.

B. Amended Water: Provide water to which a surfactant has been added shall be used to wet the 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 19 L (5 gallons) of water.

C. Removal Encapsulant: When authorized by VA, 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 removal.

3.2.2 SECONDARY BARRIER AND WALKWAYS

A. Install as a drop cloth a 0.15 mm (6-mil) poly sheet at the beginning of each work shift where removal is to be done during that shift. Completely cover non affected floors and any walls within 3 m (10 feet) of the area where work is to done. Secure the secondary barrier with duct tape to prevent it from moving or 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.

B. Install walkways using 0.15 mm (6-mil) black poly between the regulated area and the decontamination facilities (PDF and W/EDF) to protect the primary layers from contamination and damage. Install the walkways at the beginning of each shift and remove at the end of each shift.

3.2.3 WET REMOVAL OF ACM

A. Adequately and thoroughly wet the ACM to be removed prior to removal with amended water or when authorized by VA, removal encapsulant to reduce/prevent fiber release to the air. Adequate time (at a minimum two hours) must be allowed for the amended water or removal encapsulant 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 when authorized in writing by the VPIH/CIH and VA when a greater safety hazard (e.g., electricity) is present.**

B. If ACM does not wet well with amended water due to composition, coating or jacketing, remove as follows:

1. Mist work area continuously with amended water whenever necessary to reduce airborne fiber levels.
2. Remove saturated ACM in small sections. Do not allow material to dry out. As material is removed, bag material, while still wet into disposal bags. Twist the bag neck tightly, bend over (gooseneck) and seal with a minimum of three tight wraps of duct tape. Clean /decontaminate the outside of the bag of any residue and move to washdown station adjacent to W/EDF.
3. Fireproofing or Architectural Finish on Scratch Coat: Spray with a fine mist of amended water or removal encapsulant. Allow time for saturation to the substrate. Do not over saturate causing excess dripping. Scrape material from substrate. Remove material in manageable quantities and control falling to staging or floor. If the falling distance is over 6 m (20 feet), use a drop chute to contain material through descent. Remove residue remaining on the scratch coat after scraping is done using a stiff bristle hand brush. If a removal encapsulant is used, remove residue completely before the encapsulant dries. Periodically re-wet the substrate with amended water as needed to prevent drying of the material before the residue is removed from the substrate.
4. Fireproofing or Architectural Finish on Wire Lath: Spray with a fine mist of amended water or removal encapsulant. Allow time to completely saturate the material. Do not over saturate causing excess dripping. If the surface has been painted or otherwise coated, cut small holes as needed and apply amended water or removal encapsulant from above. Cut saturated wire lath into 600 x 1800 mm (2 x 6 feet) sections and cut hanger wires. Roll up complete with ACM, cover in burlap and hand place in disposal bag. Do not drop to floor. After removal of lath/ACM, remove any overspray on decking and structure using stiff bristle nylon brushes. Depending on hardness of overspray, scrapers may be needed for removal.
5. Pipe/Tank/Vessel/Boiler Insulation: Remove the outer layer of wrap while spraying with amended water in order to saturate the ACM. Spray ACM with a fine mist of amended water or removal encapsulant. Allow time to saturate the material to the substrate. Cut bands

holding pre-formed pipe insulation sections. Slit jacketing at the seams, remove and hand place in a disposal bag. Do not allow dropping to the floor. Remove molded fitting insulation/mud in large pieces and hand place in a disposal bag. Remove any residue on pipe or fitting with a stiff bristle nylon brush. In locations where pipe fitting insulation is removed from fibrous glass or other non-asbestos insulated straight runs of pipe, remove fibrous material at least 150 mm (6 inches) from the point it contacts the ACM.

3.2.4 WET REMOVAL OF AMOSITE

A. The following areas shown on drawings indicate locations of ACM which will require local exhaust ventilation and collection as described below, in addition to wet removal. Provide specific description /locations/ drawings.
B. Provide local exhaust ventilation and collection systems to assure collection of amosite fibers at the point of generation. A 300 mm (12 inches) flexible rigid non-collapsing duct shall be shall be located no more than 600 mm (2 feet) from any scraping/brushing activity. Primary filters must be replaced every 30 minutes on the negative air machines. Each scraping/brushing activity must have a negative air machine devoted to it. For pre-molded pipe insulation or cutting wire lathe attach a 1200 mm (4 feet) square flared end piece on the intake of the duct. Support the duct horizontally at a point 600 mm (2 feet) below the work to effect capture. One person in the crew shall be assigned to operate the duct collection system on a continual basis.
C. Amosite does not wet well with amended water. Submit full information/documentation on the wetting agent proposed prior to start for review and approval by the VPIH/CIH and VA Contracting Officer. Insure that the material is worked on in small sections and is thoroughly and continuously wetted. Package as soon as possible while wet. Remove as required.

3.2.5 REMOVAL OF ACM/DIRT FLOORS AND OTHER SPECIAL PROCEDURES

A. For assumed ACM of newly discovered materials not listed within the asbestos survey report dated 10/24/12 for the stairwell project located at the VA San Diego Healthcare System, the CPIH shall develop and submit a procedure for review and approval as it relates to the removal of such materials. Local exhaust, contiguous monitoring, misting and carful work practices must be listed and followed within the proposed procedure.
B. Crawlspaces/Pipe Tunnels: When working in crawlspaces or pipe tunnels, remove all visible asbestos debris using wet methods (if possible) after set-up of PDF, W/EDF, and after establishing negative air systems as required. Perform work and decontaminate/clean-up; perform lockdown as needed and complete work as required in these specifications.

3.3 LOCKDOWN ENCAPSULATION

3.3.1 GENERAL

A. Lockdown encapsulation is an integral part of the ACM removal. At the conclusion of ACM removal and before removal of the primary barriers, the Contractor shall encapsulate all surfaces with a bridging encapsulant.

3.3.2 DELIVERY AND STORAGE

A. Deliver materials to the job site in original, new and unopened containers bearing the manufacturer's name and label as well as the following information: name of material, manufacturer's stock number, date of manufacture, thinning instructions, application instructions and the MSDS for the material.

3.3.3 WORKER PROTECTION

A. Before beginning work with any material for which an MSDS has been submitted, provide workers with any required personal protective equipment. The required personal protective equipment shall be used whenever exposure to the material might occur. In addition to OSHA/specification requirements for respiratory protection, a paint pre-filter and an organic vapor cartridge, at a minimum, shall be used in addition to the HEPA filter when an organic solvent based encapsulant is used. The CPIH/CIH shall be responsible for provision of adequate respiratory protection. Note: Flammable and combustible encapsulants shall not be used, unless authorized in writing by the VA.

3.3.4 ENCAPSULATION OF SCRATCH COAT PLASTER OR PIPING

A. Apply two coats of lockdown encapsulant to the scratch coat plaster or piping after all ACM has been removed. Apply in strict accordance with the manufacturer's instructions. Any deviation from the instructions must be approved by the VA's representative in writing prior to commencing the work.

B. Apply the lockdown encapsulant with an airless sprayer at a pressure and using a nozzle orifice as recommended by the manufacturer. Apply the first coat while the while the scratch coat is still damp from the asbestos removal process, after passing the visual inspection. If the surface has been allowed to dry, wet wipe or HEPA vacuum prior to spraying with encapsulant. Apply a second coat over the first coat in strict conformance with the manufacturer's instructions. Color the lockdown encapsulant and contrast the color in the second coat so that visual confirmation of completeness and uniform coverage of each coat is possible. Adhere to the manufacturer's instructions for coloring. At the completion of the encapsulation, the surface must be a uniform third color produced by the mixture.

3.3.5 SEALING EXPOSED EDGES

A. Seal edges of ACM exposed by removal work which is inaccessible, such as a sleeve, wall penetration, etc., with two coats of bridging encapsulant. Prior to sealing, permit the exposed edges to dry completely to permit penetration of the bridging encapsulant. Apply in accordance with 3.3.4 (B).

3.4 DISPOSAL OF ACM WASTE MATERIALS

3.4.1 GENERAL

A. 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. Transport will be in compliance with 49 CFR 100–185 regulations. Disposal shall be done at an approved landfill. Disposal of non-friable ACM shall be done in accordance with applicable regulations.

3.4.2 PROCEDURES

A. The VA must be notified at least 24 hours in advance of any waste removed from the containment.

B. Asbestos waste shall be packaged and moved through the W/EDF into a covered transport container in accordance with procedures is this specification. Waste shall be double-bagged and wetted with amended water prior to disposal. Wetted waste can be very heavy. Bags shall not be overfilled. Bags shall be securely sealed to prevent accidental opening and/or leakage. The top shall be tightly twisted and goose necked 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 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.

C. Waste Load Out: Waste load out shall be done in accordance with the procedures in W/EDF Decontamination Procedures. Sealed waste bags shall be decontaminated on exterior surfaces by wet cleaning and/or HEPA vacuuming before being placed in the second waste bag and sealed, which then must also be wet wiped or HEPA vacuumed.

D. 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.

3.5 PROJECT DECONTAMINATION

3.5.1 GENERAL

A. The entire work related to project decontamination shall be performed under the close supervision and monitoring of the CPIH/CIH.
B. 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 cleanings of the surfaces of the regulated area after the primary barrier removal.
C. 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.

3.5.2 REGULATED AREA CLEARANCE

A. Clearance 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.

3.5.3 WORK DESCRIPTION

A. Decontamination includes the clearance air testing 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, and negative pressure systems.

3.5.4 PRE-DECONTAMINATION CONDITIONS

A. Before decontamination starts, all ACM waste from the regulated area shall be collected and removed, and the loose 0.15 mm (6-mil) layer of poly removed while being adequately wetted with amended water and disposed of along with any gross debris generated by the work.
B. At the start of decontamination, the following shall be in place:
   1. Primary barriers consisting of 2 layers of 0.15 mm (6-mil) poly on the floor and 0.1 mm (4-mil) poly on the walls.
   2. Critical barriers consisting of 2 layers of 0.15 mm (6-mil) poly which is the sole barrier between the regulated area and openings to the rest of the building or outside.
   3. Decontamination facilities for personnel and equipment in operating condition and the negative pressure system in operation.

3.5.5 FIRST CLEANING

A. Carry out a first cleaning of all surfaces of the regulated area including items of remaining poly sheeting, tools, scaffolding, and ladders/staging by wet methods and/or HEPA vacuuming. Do not use dry dusting/sweeping/air blowing methods. Use each surface of a wetted 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. Remove all filters in the air handling system and dispose of as ACM waste in accordance with these specifications. The negative pressure system shall remain in operation during this time. Additional cleaning(s) may be needed as determined by the CPIH/VPIH/CIH.

3.5.6 PRE-CLEARANCE INSPECTION AND TESTING

A. Any on-site technician, industrial hygienist, certified industrial hygienist conducting any on-site monitoring, inspections, air sampling, and testing shall be certified through the State of California Division of Occupational Safety and Health (DOSH) as a Certified Asbestos Consultant (CAC) or a Site Surveillance Technician (SST) performing only approved activities under the direction of a CAC.
B. The CPIH/CIH and VPIH/CIH will perform a thorough and detailed visual inspection at the end of the cleaning to determine whether there is any visible residue in the regulated area. If the visual

inspection is acceptable, the CPIH/CIH 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/CIH 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.

3.5.7 LOCKDOWN ENCAPSULATION OF ABATED SURFACES

A. 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. Negative pressure shall be maintained in the regulated area during the lockdown application.

3.6 FINAL VISUAL INSPECTION AND AIR CLEARANCE TESTING

3.6.1 GENERAL

A. 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 starting after the final cleaning.

3.6.2 FINAL VISUAL INSPECTION

A. 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.

3.6.3 FINAL AIR CLEARANCE TESTING

A. After an acceptable final visual inspection by the VPIH/CIH and VA Representative, the VPIH/CIH will perform the final clearance testing who is certified through the State of California Division of Occupational Safety and Health (DOSH) as a Certified Asbestos Consultant (CAC). Air samples will be collected and analyzed in accordance with procedures for AHERA in this specification. If work is less than 80 m/ 15 m^2/ 1 m^3 (260 lf/ 160 ft^2/ 35 ft^3), 5 PCM samples shall be collected for clearance and a minimum of one field blank. If work is equal to or more than 80 m/ 15 m^2/ 1 m^3 (260 lf/ 160 ft^2/ 35 ft^3), AHERA TEM sampling shall be performed for clearance. TEM analysis shall be done in accordance with procedures for EPA AHERA in this specification. If the release criteria are not met, the Contractor shall repeat the final cleaning and continue decontamination procedures until clearance is achieved. **All additional inspection and testing costs will be borne by the Contractor**.

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

3.6.4 FINAL AIR CLEARANCE PROCEDURES

A. Contractor's Release Criteria: Work in a regulated area is complete when the regulated area is visually clean and airborne fiber levels have been reduced to be at or below 0.01 f/cc as measured by the AHERA PCM protocol, or 70 AHERA structures per square millimeter (s/mm^2) by AHERA TEM.

B. 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:

1. 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 AHERA TEM method.
2. Aggressive Sampling: All final air testing samples shall be collected using aggressive sampling techniques. Samples will be collected on 0.8µ MCE filters for PCM analysis and 0.45µ Polycarbonate filters for TEM. A minimum of 1200 Liters of using calibrated pumps shall be collected for clearance samples. Before pumps are started, initiate aggressive air mixing 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. The negative pressure system shall continue to operate.

3.6.5 CLEARANCE SAMPLING USING PCM – LESS THAN 260LF/160SF:

A. The VPIH/CIH will perform clearance samples as indicated by the specification.
B. The NIOSH 7400 PCM method will be used for clearance sampling with a minimum collection volume of 1200 Liters of air. A minimum of 5 PCM clearance samples shall be collected. All samples must measure at or less than 0.01 f/cc to clear the regulated area.

3.6.6 CLEARANCE SAMPLING USING TEM – EQUAL TO OR MORE THAN 260LF/160SF: TEM

A. Clearance requires 13 samples be collected; 5 inside the regulated area; 5 outside the regulated area; and 3 field blanks.
B. The TEM method will be used for clearance sampling with a minimum collection volume of 1200 Liters of air. A minimum of 13 clearance samples shall be collected. All samples must measure at equal to or less than 70 AHERA structures per square millimeter (s/mm^2) AHERA TEM.

3.6.7 LABORATORY TESTING OF PCM CLEARANCE SAMPLES

A. The services of an AIHA accredited laboratory will be employed by the VA to perform analysis for the PCM air samples. The accredited laboratory shall be successfully participating in the AIHA Proficiency Analytical Testing (PAT) program. Samples will be sent daily 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.

3.6.8 LABORATORY TESTING OF TEM SAMPLES

A. Samples shall be sent by the VPIH/CIH to a NIST accredited laboratory for analysis by TEM. The laboratory shall be successfully participating in the NIST Airborne Asbestos Analysis (TEM) program. 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.

3.6.9 LABORATORY TESTING OF BULK SAMPLES

A. Samples shall be sent by the VPIH/CIH or CPIH/CIH to a NIST accredited laboratory for analysis by PLM. The laboratory shall be successfully participating in the NIST Bulk Asbestos Analysis (PLM) program. 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.

3.7 ABATEMENT CLOSEOUT AND CERTIFICATE OF COMPLIANCE

3.7.1 COMPLETION OF ABATEMENT WORK

A. After thorough decontamination, seal negative air machines with 2 layers of 0.15 mm (6-mil) poly and duct tape to form a tight seal at the intake/outlet ends before removal from the regulated area. Complete asbestos abatement work upon meeting the regulated area visual and air clearance criteria and fulfilling the following:
   1. Remove all equipment and materials from the project area.
   2. Dispose of all packaged ACM waste as required.
   3. Repair or replace all interior finishes damaged during the abatement work, as required.
   4. Fulfill other project closeout requirements as required in this specification.

3.7.2 CERTIFICATE OF COMPLETION BY CONTRACTOR

A. The CPIH/CIH 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.

3.7.3 WORK SHIFTS

A. 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.

3.7.4 RE-INSULATION

A. If required as part of the contract, replace all asbestos containing insulation/fire-proofing with suitable non-asbestos material. Provide MSDS's for all replacement materials in advance of installation for VA approval. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

- - - END - - -

ATTACHMENT #1

CERTIFICATE OF COMPLETION

DATE: ________________ VA Project #: ______________________________

PROJECT NAME:______________Abatement Contractor:____________________

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 abatement work was done in accordance with OSHA requirements and the manufacturer’s recommendations.

CPIH/CIH Signature/Date:..

CPIH/CIH Print Name:..

Abatement Contractor Signature/Date:..

Abatement Contractor Print Name:..

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 ARE 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/CIH:____Date:______________

Printed Name of CPIH/CIH: ________________________________

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 (have) 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__________

SECTION 03 30 53
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION:

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

1.2 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

1.3 TOLERANCES:

A. ACI 117.

B. Slab Finishes: ACI 117, F-number method in accordance with ASTM E1155.

1.4 REGULATORY REQUIREMENTS:

A. ACI SP-66 ACI Detailing Manual

B. ACI 318 - Building Code Requirements for Reinforced Concrete.

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Concrete Mix Design.

C. Shop Drawings: Reinforcing steel: Complete shop drawings.

D. Manufacturer's Certificates: Air-entraining admixture, chemical admixtures, curing compounds.

1.6 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):

117R-06 ....Tolerances for Concrete Construction and Materials
211.1-91(R2002)........................Proportions for Normal, Heavyweight, and Mass Concrete
211.2-98(R2004)........................Proportions for Structural Lightweight Concrete
301-05.......................................Specification for Structural Concrete
305R-06 ....Hot Weather Concreting
306R-2002 ....Cold Weather Concreting
SP-66-04 ....ACI Detailing Manual
318/318R-05 ....Building Code Requirements for Reinforced Concrete
347R-04 ....Guide to Formwork for Concrete

C. American Society for Testing And Materials (ASTM):

A185-07.....................................Steel Welded Wire, Fabric, Plain for Concrete Reinforcement
A615/A615M-08 ....Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

A996/A996M-06 ....Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

C31/C31M-08............................Making and Curing Concrete Test Specimens in the Field

C33-07 ....Concrete Aggregates

C39/C39M-05............................Compressive Strength of Cylindrical Concrete Specimens

C94/C94M-07............................Ready-Mixed Concrete

C143/C143M-05........................Standard Test Method for Slump of Hydraulic Cement Concrete

C150-07 ....Portland Cement

C171-07 ....Sheet Material for Curing Concrete

C172-07 ....Sampling Freshly Mixed Concrete

C173-07.Air Content of Freshly Mixed Concrete by the Volumetric Method

C192/C192M-07........................Making and Curing Concrete Test Specimens in the Laboratory

C231-08 ....Air Content of Freshly Mixed Concrete by the Pressure Method

C260-06 ....Air-Entraining Admixtures for Concrete

C330-05 ....Lightweight Aggregates for Structural Concrete

C494/C494M-08........................Chemical Admixtures for Concrete

C618-08 ....Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

D1751-04.Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

D4397-02 ....Polyethylene Sheeting for Construction, Industrial and Agricultural Applications

E1155-96(2008) ....Determining F_F Floor Flatness and F_L Floor Levelness Numbers

PART 2 - PRODUCTS

2.1 FORMS:

Wood, plywood, metal, or other materials, approved by Project Engineer, of grade or type suitable to obtain type of finish specified.

2.2 MATERIALS:

A. Portland Cement: ASTM C150, Type I or II.

B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.

C. Coarse Aggregate: ASTM C33, Size 67. Size 467 may be used for footings and walls over 300 mm (12 inches) thick. Coarse aggregate for applied topping and metal pan stair fill shall be Size 7.

D. Fine Aggregate: ASTM C33.

E. Lightweight Aggregate for Structural Concrete: ASTM C330, Table 1

F. Mixing Water: Fresh, clean, and potable.

G. Air-Entraining Admixture: ASTM C260.

H. Chemical Admixtures: ASTM C494.

I. Vapor Barrier: ASTM D4397, 0.25 mm (10 mil).

J. Reinforcing Steel: ASTM A615 or ASTM A996, deformed. See structural drawings for grade.

K. Welded Wire Fabric: ASTM A185.

L. Expansion Joint Filler: ASTM D1751.

M. Sheet Materials for Curing Concrete: ASTM C171.

N. Abrasive Aggregates: Aluminum oxide grains or emery grits.

O. Liquid Densifier/Sealer: 100 percent active colorless aqueous siliconate solution.

P. Grout, Non-Shrinking: Premixed ferrous or non-ferrous, mixed and applied in accordance with manufacturer's recommendations. Grout shall show no settlement or vertical drying shrinkage at 3 days or thereafter based on initial measurement made at time of placement, and produce a compressive strength of at least 18mpa (2500 psi) at 3 days and 35mpa (5000 psi) at 28 days.

2.3 CONCRETE MIXES:

A. Design of concrete mixes using materials specified shall be the responsibility of the Contractor as set forth under Option C of ASTM C94.

B. Compressive strength at 28 days shall be not less than 30 Mpa 4000 psi.

C. Establish strength of concrete by testing prior to beginning concreting operation. Test consists of average of three cylinders made and cured in accordance with ASTM C192 and tested in accordance with ASTM C39.

D. Maximum slump for vibrated concrete is 100 mm (4 inches) tested in accordance with ASTM C143.

E. Cement and water factor (See Table I):

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^3 (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement kg/m^3 (lbs/c. yd)	Max. Water Cement Ratio
35 (5000)[1,3]	375 (630)	0.45	385 (650)	0.40
30 (4000)[1,3]	325 (550)	0.55	340 (570)	0.50
25 (3000)[1,3]	280 (470)	0.65	290 (490)	0.55
25 (3000)[1,2]	300 (500)	*	310 (520)	*

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. Lightweight Structural Concrete. Pump mixes may require higher cement values.
3. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.

* Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.

2.4 BATCHING & MIXING:

A. Store, batch, and mix materials as specified in ASTM C94.

1. Job-Mixed: Concrete mixed at job site shall be mixed in a batch mixer in manner specified for stationary mixers in ASTM C94.
2. Ready-Mixed: Ready-mixed concrete comply with ASTM C94, except use of non-agitating equipment for transporting concrete to the site will not be permitted. With each load of concrete delivered to project, ready-mixed concrete producer shall furnish, in duplicate, certification as required by ASTM C94.
3. Mixing structural lightweight concrete: Charge mixer with 2/3 of total mixing water and all of the aggregate. Mix ingredients for not less than 30 seconds in a stationary mixer or not less than 10 revolutions at mixing speed in a truck mixer. Add remaining mixing water and other ingredients and continue mixing. Above procedure may be modified as recommended by aggregate producer.

PART 3 - EXECUTION

3.1 FORMWORK:

A. Installation conform to ACI 347. Sufficiently tight to hold concrete without leakage, sufficiently braced to withstand vibration of concrete, and to carry, without appreciable deflection, all dead and live loads to which they may be subjected.

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. Inserts, sleeves, and similar items: Flashing reglets, masonry ties, anchors, inserts, wires, hangers, sleeves, boxes for floor hinges 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.

D. Construction Tolerances:

1. Contractor is responsible for setting and maintaining concrete formwork to assure erection of completed work within tolerances specified to accommodate installation or other rough and finish materials. Remedial work necessary for correcting excessive tolerances is the

responsibility of the Contractor. 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 REINFORCEMENT:

Details of concrete reinforcement, unless otherwise shown, in accordance with ACI 318 and ACI SP-66. Support and securely tie reinforcing steel to prevent displacement during placing of concrete.

3.3 VAPOR BARRIER:

Except where membrane waterproofing is required, place interior concrete slabs on a continuous vapor barrier.

A. Place 100 mm (4 inches) of fine granular fill over the vapor barrier to act as a blotter for concrete slab.

B. Lap joints 150 mm (6 inches) and seal with a compatible pressure-sensitive tape.

C. Patch punctures and tears.

3.4 PLACING CONCRETE:

A. Remove water from excavations before concrete is placed. Remove hardened concrete, debris and other foreign materials from interior of forms, and from inside of mixing and conveying equipment. Obtain approval of Project Engineer before placing concrete. Provide screeds at required elevations for concrete slabs.

B. Before placing new concrete on or against concrete which has set, existing surfaces shall be roughened and cleaned free from all laitance, foreign matter, and loose particles.

C. Convey concrete from mixer to final place of deposit by method which will prevent segregation or loss of ingredients. Do not deposit in work concrete that has attained its initial set or has contained its water or cement more than 1 1/2 hours. Do not allow concrete to drop freely more than 1500 mm (5 feet) in unexposed work nor more than 900 mm (3 feet) in exposed work. Place and consolidate concrete in horizontal layers not exceeding 300 mm (12 inches) in thickness. Consolidate concrete by spading, rodding, and mechanical vibrator. Do not secure vibrator to forms or reinforcement. Vibration shall be carried on continuously with placing of concrete.

D. Hot weather placing of concrete: Follow recommendations of ACI 305R to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete.

E. Cold weather placing of concrete: Follow recommendations of ACI 306R, to prevent freezing of thin sections less than 300 mm (12 inches) and to permit concrete to gain strength properly, except that use of calcium chloride shall not be permitted without written approval from Project Engineer.

3.5 PROTECTION AND CURING:

Protect exposed surfaces of concrete from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method shall be subject to approval by Project Engineer.

3.6 FORM REMOVAL:

Forms remain in place until concrete has a sufficient strength to carry its own weight and loads supported. Removal of forms at any time is the Contractor's sole responsibility.

3.7 SURFACE PREPARATION:

Immediately after forms have been removed and work has been examined and approved by Project Engineer, remove loose materials, and patch all stone pockets, surface honeycomb, or similar deficiencies with cement mortar made with 1 part portland cement and 2 to 3 parts sand.

3.8 FINISHES:

A. Vertical and Overhead Surface Finishes:
   1. Unfinished Areas: Vertical and overhead concrete surfaces exposed in unfinished areas, above suspended ceilings in manholes, and other unfinished areas exposed or concealed will not require additional finishing.
   2. Interior and Exterior Exposed Areas (to be painted): Fins, burrs and similar projections on surface shall be knocked off flush by mechanical means approved by Project Engineer and rubbed lightly with a fine abrasive stone or hone. Use an ample amount of water during rubbing without working up a lather of mortar or changing texture of concrete.
   3. Interior and Exterior Exposed Areas (finished): Finished areas, unless otherwise shown, shall be given a grout finish of uniform color and shall have a smooth finish treated as follows:
      a. After concrete has hardened and laitance, fins and burrs have been removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone or stone.
      b. Apply grout composed of 1 part portland cement and 1 part clean, fine sand (smaller than 600 micro-m (No. 30) sieve). Work grout into surface of concrete with cork floats or fiber brushes until all pits and honeycomb are filled.
      c. After grout has hardened, but still plastic, remove surplus grout with a sponge rubber float and by rubbing with clean burlap.
      d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish for any area in same day. Confine limits of finished areas to natural breaks in wall surface. Do not leave grout on concrete surface overnight.

B. Slab Finishes:
   1. Scratch Finish: Slab surfaces to receive a bonded applied cementitious application shall all be thoroughly raked or wire broomed after partial setting (within 2 hours after placing) to roughen surface to insure a permanent bond between base slab and applied cementitious materials.

2. Floating: Allow water brought to surface by float used for rough finishing to evaporate before surface is again floated or troweled. Do not sprinkle dry cement on surface to absorb water.
3. Float Finish: Ramps, stair treads, and platforms, both interior and exterior, equipment pads, and slabs to receive non-cementitious materials, except as specified, shall be screened and floated to a smooth dense finish. After first floating, while surface is still soft, surfaces shall be checked for alignment using a straightedge or template. Correct high spots by cutting down with a trowel or similar tool and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections on floated finish by rubbing or dry grinding. Refloat the slab to a uniform sandy texture.
4. Steel Trowel Finish: Applied toppings, concrete surfaces to receive resilient floor covering or carpet, future floor roof and all monolithic concrete floor slabs exposed in finished work and for which no other finish is shown or specified shall be steel troweled. Final steel troweling to secure a smooth, dense surface shall be delayed as long as possible, generally when the surface can no longer be dented with finger. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure on trowel to compact cement paste and form a dense, smooth surface. Finished surface shall be free of trowel marks, uniform in texture and appearance.
5. Broom Finish: Finish all exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after the surfaces have been floated.
6. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:

Slab on grade & Shored suspended slabs	Unshored suspended slabs
Specified overall value F_F 25/F_L 20	Specified overall value F_F 25
Minimum local value F_F 17/F_L 15	Minimum local value F_F 17

3.9 SURFACE TREATMENTS:

A. Surface treatments shall be mixed and applied in accordance with manufacturer's printed instructions.
B. Liquid Densifier/Sealer: Use on all exposed concrete floors and concrete floors to receive carpeting except those specified to receive non-slip finish.
C. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of all concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Aggregate shall be broadcast uniformly over concrete surface. Trowel concrete surface to smooth dense finish. After curing, rub the treated surface with abrasive brick and water sufficiently to slightly expose abrasive aggregate.

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SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION:

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. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Painting: Section 09 91 00, PAINTING.

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 Category Conventional Steel Structures fabrication plant.

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 Project Engineer.

1.4 TOLERANCES:

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 ASD Manual, 13th Edition, Page 1-145, except as follows:

A. Elevation tolerance for column splice points at time member is erected is 10 mm (3/8 inch).

B. 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).

C. 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. Connections: Design and detail all connections for each member size, steel grade and connection type to resist the loads and reactions indicated on the drawings or specified herein. Use details consistent with the details shown on the Drawings, supplementing where necessary. The details shown on the Drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Project Engineer of any location where the connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the Project Engineer. Submit structural calculations prepared and sealed by a qualified engineer registered in the state where the project is located. Submit calculations for review before preparation of detail drawings.

1.6 REGULATORY REQUIREMENTS:

A. AISC: Specification for Structural Steel Buildings - Allowable Stress Design.

B. AISC: Code of Standard Practice for Steel Buildings and Bridges.

1.7 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Shop and Erection Drawings: Complete

C. Certificates:

1. Structural steel.
2. Steel for all connections.
3. Welding materials.
4. Shop coat primer paint.

D. Test Reports:

1. Welders' qualifying tests.

E. Design Calculations and Drawings:

1. Connection calculations, if required.

F. Record Surveys.

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 - Allowable Stress Design and Plastic Design (Second Edition, 2005)
2. Load and Resistance Factor Design Specification for Structural Steel Buildings (Second Edition, 1995)
3. Code of Standard Practice for Steel Buildings and Bridges (2010).

C. American National Standards Institute (ANSI):

B18.22.1-65(R2008) .... Plain Washers

B18.22M-81(R2000) .... Metric Plain Washers

D. American Society for Testing and Materials (ASTM):

A6/A6M-09 .... Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A36/A36M-08 .... Standard Specification for Carbon Structural Steel

A53/A53M-10 .... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

A123/A123M-09 ....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A242/A242M-04(R2009) ....Standard Specification for High-Strength Low-Alloy Structural Steel

A283/A283M-03(R2007) ....Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

A307-10.....................................Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

A325-10.....................................Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A490-10.....................................Standard Specification for Heat-Treated Steel Structural Bolts 150 ksi Minimum Tensile Strength

A500/A500M-10 ....Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A501-07.....................................Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

A572/A572M-07 ....Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

A992/A992M-06 ....Standard Specification for Structural Steel Shapes

E. American Welding Society (AWS):

D1.1/D1.1M-10...........................Structural Welding Code-Steel

F. Research Council on Structural Connections (RCSC) of The Engineering Foundation:

Specification for Structural Joints Using ASTM A325 or A490 Bolts

G. Military Specifications (Mil. Spec.):

MIL-P-21035 ....Paint, High Zinc Dust Content, Galvanizing, Repair

H. Occupational Safety and Health Administration (OSHA):

29 CFR Part 1926-2001.............Safety Standards for Steel Erection

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Structural Steel: ASTM A992.

B. Structural Tubing: ASTM A500, Grade B.

C. Steel Pipe: ASTM A53, Grade B.

D. Bolts, Nuts and Washers:

1. High-strength bolts, including nuts and washers: ASTM A325.
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.

E. Zinc Coating: ASTM A123.

F. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035.

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 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. Twist-off torque bolts are not an acceptable alternate fastener for slip critical connections.

3.2 FABRICATION:

Fabrication in accordance with Chapter M, Specification for Steel Buildings - Allowable Stress Design and Plastic Design.

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. Structural steel in the interstitial space that does not receive sprayed on fireproofing shall be painted with primer in accordance with general requirement of shop painting.

E. 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.

3.4 ERECTION:

A. General: Erection in accordance with Section 7, Code of Standard Practice for Steel Buildings and Bridges.

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.

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.

3.6 SURVEY:

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 Project 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 AISC Manual.

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SECTION 05 31 00
STEEL DECKING

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies material and services required for installation of steel decking as shown and specified.

1.2 RELATED WORK:

A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Finish Painting: Section 09 91 00, PAINTING.

1.3 DESIGN REQUIREMENTS:

A. Design steel decking in accordance with AISI publication, "Specification for the Design of Cold-formed Steel Structural Members" except as otherwise shown or specified.

B. Design all elements with the latest published version of applicable codes.

1.4 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 similar information necessary for completing installation as shown and specified, including supplementary framing, sump pans, ridge and valley plates, 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.

D. 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”.

E. Insurance Certification: Assist the Government in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance.

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):

A36/A36M-08 ....Standard Specification for Carbon Structural Steel

A611-97 .... Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled

A653/A653M-08 .... Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process

C423-08 .... Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

C. American Institute of Steel Construction (AISC):
   1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design (ninth Edition, 1989)
   2. Load and Resistance Factor Design Specification for Structural Steel Buildings (Latest Edition)

D. American Iron and Steel Institute (AISI):
   1. Specification and Commentary for the Design of Cold-Formed Steel Structural Members

E. American Welding Society (AWS):

   D1.3-08 .... Structural Welding Code - Sheet Steel

F. Factory Mutual (FM Global):
   1. Loss Prevention Data Sheet 1-28: Wind Loads to Roof Systems and Roof Deck Securement
   2. Factory Mutual Research Approval Guide (2002)

G. Military Specifications (Mil. Spec.)

   MIL-P-21035B .... Paint, High Zinc Dust Content, Galvanizing Repair

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Steel Decking: ASTM A653, Structural Quality.

B. Galvanizing: ASTM A653, G90.

C. Galvanizing Repair Paint: Mil. Spec. MIL-P-21035B.

D. Primer for Shop Painted Sheets: Manufacturer's standard primer (2 coats). When finish painting of steel decking is specified in Section 09 91 00, PAINTING primer coating shall be compatible with specified finish painting.

E. Miscellaneous Steel Shapes: ASTM A36.

F. Welding Electrode: E60XX minimum.

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, concrete slab edges and roof deck edges. 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. Ridge and Valley Plates: Provide 1.3 mm (18 gauge), minimum 100 mm (4 inch) wide ridge and valley plates where roof slope exceeds 40 mm per meter (1/2 inch per foot).
5. Cant Strips: Provide bent metal 45 degree leg cant strips where indicated on the Drawings. Fabricate cant strips from 1 mm (20 gauge) metal with a minimum 125 mm (5 inch) face width.
6. Seat Angles for Deck: Provide where a beam does not frame into a column.
7. Sump Pans for Roof Drains: Fabricated from single piece of minimum 1.9 mm (14 gauge) galvanized sheet steel with level bottoms and sloping sides to direct water flow to drain, unless otherwise shown. Provide sump pans of adequate size to receive roof drains and with bearing flanges not less than 75 mm (3 inches) wide. Recess pans not less than 38 mm (1 1/2 inches) below roof deck surface, unless otherwise shown or required by deck configuration. Holes for drains will be cut in the field.

2.2 REQUIREMENTS:

A. Provide steel decking of the type, depth, gauge, and section properties as shown.
B. Metal Roof Deck: Single pan fluted units with flat horizontal top surfaces utilized to act as a permanent support for all superimposed loads. Comply with the depth and minimum gage requirements as shown on the Contract Documents.
   1. Wide Rib (Type B) deck.
   2. Finish: Galvanized G-90.
C. Do not use steel deck for hanging supports for any type or kind of building components including suspended ceilings, electrical light fixtures, plumbing, heating, or air conditioning pipes or ducts or electrical conduits.

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. Provide steel decking in sufficient lengths to extend over 3 or more spans, except for interstitial levels.

E. Place steel decking units at right angles to supporting members. End laps of sheets of roof deck shall be a minimum of 50 mm (2 inches) and shall occur over supports.

F. Fastening Deck Units:

1. Fasten floor deck units to steel supporting members by not less than 16 mm (5/8 inch) diameter puddle welds or elongated welds of equal strength, spaced not more than 305 mm (12 inches) o.c. with a minimum of two welds per unit at each support. Where two units abut, fasten each unit individually to the supporting steel framework.
2. Tack weld or use self-tapping No. 8 or larger machine screws at 915 mm (3 feet) o.c. for fastening end closures. Only use welds to attach longitudinal end closures.
3. Weld side laps of adjacent floor deck units that span more than 1524 mm (5 feet). Fasten at midspan or 915 mm (3 feet) o.c., whichever is smaller.
4. Fasten roof deck units to steel supporting members by not less than 16 mm (5/8 inch) diameter puddle welds or elongated welds of equal strength, spaced not more than 305 mm (12 inches) o.c. at every support, and at closer spacing where required for lateral force resistance by diaphragm action. Attach split or partial panels to the structure in every valley. In addition, secure deck to each supporting member in ribs where side laps occur. Power driven fasteners may be used in lieu of welding for roof deck if strength equivalent to the welding specified above is provided. Submit test data and design calculations verifying equivalent design strength.
5. Mechanically fasten side laps of adjacent roof deck units with spans greater than 1524 mm (5 feet) between supports, at intervals not exceeding 915 mm (3 feet) o.c., or midspan, whichever is closer, using self-tapping No. 8 or larger machine screws.
6. Provide any additional fastening necessary to comply with the requirements of Underwriters Laboratories and/or Factory Mutual to achieve the required ratings.
7. Uplift Loading: Install and anchor roof deck units to resist gross uplift loading of 2.1 kPa (45 psf) at eave overhang and 1.4 kPa (30 psf) for other roof areas.

G. 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 Project 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.

3.2 WELDING:

Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.3.

3.3 FIELD REPAIR:

1. Areas scarred during erection.
2. Welds to be thoroughly cleaned and touched-up. Touch-up paint for zinc-coated units shall be zinc rich galvanizing repair paint.

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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. Frames
3. Guards
4. Covers and Frames for Pits and Trenches.
5. Gratings
6. Shelf Angles
7. Gas Racks
8. Ladders
9. Railings
10. Catwalks and Platforms

1.2 RELATED WORK

A. Colors, finishes, and textures: Section 09 06 00, SCHEDULE FOR FINISHES.

B. 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:

Grating, each type	Floor plate

C. 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.

D. Manufacturer's Certificates:

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

E. Design Calculations for specified live loads including dead loads.

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. Each product type shall be the same and be made by the same manufacturer.

C. Assembled product to the greatest extent possible before delivery to the site.

D. 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):

B18.2.2-87(R2005) .... Square and Hex Nuts

C. American Society for Testing and Materials (ASTM):

A36/A36M-08 .... Structural Steel
A47-99(R2009).......................... Malleable Iron Castings
A48-03(R2008).......................... Gray Iron Castings
A53-10....................................... Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A123-09..................................... Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A307-10..................................... Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A653/A653M-10 .... Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
A786/A786M-09 .... Rolled Steel Floor Plate
C1107-08 .... Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
F436-10..................................... Hardened Steel Washers
F468-10..................................... Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
F593-02(R2008)........................ Stainless Steel Bolts, Hex Cap Screws, and Studs

D. American Welding Society (AWS):

D1.1-10 .... Structural Welding Code Steel
D1.3-08 .... Structural Welding Code Sheet Steel

E. National Association of Architectural Metal Manufacturers (NAAMM)

AMP 521-01 .... Pipe Railing Manual
AMP 500-06 .... Metal Finishes Manual

MBG 531-09..............................Metal Bar Grating Manual

MBG 532-09..............................Heavy Duty Metal Bar Grating Manual

F. Structural Steel Painting Council (SSPC)/Society of Protective Coatings:

SP 1-04 ....No. 1, Solvent Cleaning

SP 2-04 ....No. 2, Hand Tool Cleaning

SP 3-04 ....No. 3, Power Tool Cleaning

G. Federal Specifications (Fed. Spec):

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.

D. Floor Plates, Gratings, Covers, Trap Doors, Catwalks, and Platforms: 500 kg/m^2 (100 pounds per square foot). Use 140 kg (300 pounds) for concentrated loads.

E. Manhole Covers: 1200 kg/m^2 (250 pounds per square foot).

2.2 MATERIALS

A. Structural Steel: ASTM A36.

B. Floor Plate:

1. Steel ASTM A786.

C. Steel Pipe: ASTM A53.

1. Galvanized for exterior locations.
2. Type S, Grade A unless specified otherwise.
3. NPS (inside diameter) as shown.

D. Malleable Iron Castings: A47.

E. Primer Paint: As specified in Section 09 91 00, PAINTING.

F. Grout: ASTM C1107, pourable type.

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.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self drilling and tapping screws or bolts.

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. Anchors:
   a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25 mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.
   b. Where metal fabrications are shown to be built into masonry use 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 250 mm (10 inches) long with 50 mm (2 inch) hooked end, welded to back of member at 600 mm (2 feet) on center, unless otherwise shown.
5. 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.

G. Protection:

1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.5 SUPPORTS

A. General:

1. Fabricate ASTM A36 structural steel shapes as shown.
2. Use clip angles or make provisions for welding hangers and braces to overhead construction.
3. Field connections may be welded or bolted.

B. For Trapeze Bars:

1. Construct assembly above ceilings as shown and design to support not less than a 340 kg (750 pound) working load at any point.
2. Fabricate concealed components of structural steel shapes unless shown otherwise.
3. Continuously weld connections where welds shown.
4. 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 FRAMES

A. Frames for Breech Opening:

1. Fabricate from steel channels, or combination of steel plates and angles to size and contour shown.
2. Weld strap anchors on back of frame at not over 600 mm (2 feet) on centers for concrete or masonry openings.

2.7 GUARDS

A. Edge Guard Angles for Openings in slabs.

1. Fabricate from steel angles of sizes and with anchorage shown.
2. Where size of angle is not shown, provide 50 x 50 x 6 mm (2 x 2 x 1/4 inch) steel angle with 32 x 5 mm (1-1/4 x 3/16 inch) strap anchors, welded to back.
3. Miter or butt angles at corners and weld.
4. Use one anchor near end and three feet on centers between end anchors.

2.8 COVERS AND FRAMES FOR PITS AND TRENCHES

A. Fabricate covers to support live loads specified.

B. Galvanized steel members after fabrication in accordance with ASTM A123, G-90 coating.

C. Steel Covers:

1. Use 6 mm (1/4 inch) thick floor plate for covers unless otherwise shown. Use gratings where shown as specified in paragraph GRATINGS. Use smooth floor plate unless noted otherwise.
2. Provide clearance at all sides to permit easy removal of covers.
3. Make cutouts within 6 mm (1/4 inch) of penetration for passage of pipes and ducts.
4. Drill covers for flat head countersunk screws.
5. Make cover sections not to exceed 2.3 m^2 (25 square feet) in area and 90 kg (200 pounds) in weight.
6. Fabricate trench cover sections not be over 900 mm (3 feet) long and if width of trench is more than 900 mm (3 feet)or over, equip one end of each section with an angle or "T" bar stiffener to support adjoining plate.
7. Use two, 13 mm (1/2 inch) diameter steel bar flush drop handles for each cover section.

D. Cast Iron Covers

1. Fabricate covers to support live loads specified.
2. Fabricate from ASTM A48, cast-iron, 13 mm (1/2 inch) minimum metal thickness, cast with stiffeners as required.
3. Fabricate as flush type with frame, reasonably watertight and be equipped with flush type lifting rings. Provide seals where watertight covers noted.
4. Make covers in sections not over 90 kg (200 pounds) except round covers.

E. Steel Frames:

1. Form frame from structural steel angles as shown. Where not shown use 63 x 63 x 6 mm (2-1/2 x 2-1/2 x 1/4 inch) angles for frame openings over 1200 mm (4 feet) long and 50 x 50 x 6 mm (2 ix 2 x 1/4 inch) for frame openings less than 1200 mm (4 feet).
2. Fabricate intermediate supporting members from steel "T's" or angles; located to support cover section edges.
3. Where covers are required use steel border bars at frames so that top of cover will be flush with frame and finish floor.
4. Weld steel strap anchors to frame. Space straps not over 600 mm (24 inches) o.c., not shown otherwise between end anchors. Use 6 x 25 x 200 mm (1/4 x 1 x 8 inches) with 50 mm (2 inch) bent ends strap anchors unless shown otherwise.
5. Drill and tap frames for screw anchors where plate covers occur.

F. Cast Iron Frames:

1. Fabricate from ASTM A48 cast iron to shape shown.
2. Provide anchors for embedding in concrete, spaced near ends and not over 600 mm (24 inches) apart.

2.9 GRATINGS

A. Fabricate gratings to support live loads specified and a concentrated load as specified.

B. Provide clearance at all sides to permit easy removal of grating.

C. Make cutouts in gratings with 6 mm (1/4 inch) minimum to 25 mm (one inch) maximum clearance for penetrations or passage of pipes and ducts. Edge band cutouts.

D. Fabricate in sections not to exceed 2.3 m^2 (25 square feet) in area and 90 kg (200 pounds) in weight.

E. Fabricate sections of grating with end-banding bars.

F. Fabricate angle frames and supports, including anchorage as shown.

1. Fabricate intermediate supporting members from "T's" or angles.
2. Locate intermediate supports to support grating section edges.
3. Fabricate frame to finish flush with top of grating.
4. Locate anchors at ends and not over 600 mm (24 inches) o.c.
5. Butt or miter, and weld angle frame at corners.

G. Steel Bar Gratings:

1. Fabricate grating using steel bars, frames, supports and other members shown in accordance with Metal Bar Grating Manual.
2. Galvanize steel members after fabrication in accordance with ASTM A123, G-90 for exterior gratings, gratings in concrete floors, and interior grating where specified.
3. Interior gratings: Prime paint unless specified galvanized.

H. Plank Gratings:

1. Conform to Fed. Spec. RR-G-1602.
2. Manufacturers standard widths, lengths and side channels to meet live load requirements.
3. Galvanize exterior steel gratings ASTM A123, G-90 after fabrication.
4. Fabricate interior steel gratings from galvanized steel sheet, ASTM A525, where bearing on concrete or masonry.
5. Fabricate other interior grating from steel sheet and finish with shop prime paint. Prime painted galvanized sheet may be used.

I. Cast Iron Gratings:

1. Fabricate gratings to support a live load of 23940 Pa (500 pounds per square foot).
2. Fabricate gratings and frames for gutter type drains from cast-iron conforming to ASTM A48.
3. Fabricate gratings in section not longer than 1200 mm (4 feet) or over 90 kg (200 pounds) and fit so as to be readily removable.

2.10 SHELF ANGLES

A. Fabricate from steel angles of size shown.

B. Fabricate angles with horizontal slotted holes for 19 mm (3/4 inch) bolts spaced at not over 900 mm (3 feet) on centers and within 300 mm (12 inches) of ends.

C. Provide adjustable malleable iron inserts for embedded in concrete framing.

2.12 LADDERS

A. Steel Ladders:

1. Fixed-rail type with steel rungs shouldered and headed into and welded to rails.
2. Fabricate angle brackets of 50 mm (2 inch) wide by 13 mm (1/2 inch) thick steel; brackets spaced maximum of 1200 mm (4 feet) apart and of length to hold ladder 175 mm (7 inches) from wall to center of rungs. Provide turned ends or clips for anchoring.
3. Provide holes for anchoring with expansion bolts through turned ends and brackets.
4. Where shown, fabricate side rails curved, twisted and formed into a gooseneck.
5. Galvanize exterior ladders after fabrication, ASTM A123, G-90.

B. Ladder Rungs:

1. Fabricate from 25 mm (one inch) diameter steel bars.
2. Fabricate so that rungs will extend at least 100 mm (4 inches) into wall with ends turned 50 mm (2 inches), project out from wall 175 mm (7 inches), be 400 mm (16 inches) wide and be designed so that foot cannot slide off end.
3. Galvanized after fabrication, ASTM A123, G-90 rungs for exterior use and for access to pits.

2.13 RAILINGS

A. In addition to the dead load design railing assembly to support live load specified.

B. Fabrication General:

1. Provide continuous welded joints, dressed smooth and flush.
2. Standard flush fittings, designed to be welded, may be used.
3. Exposed threads will not be approved.
4. Form handrail brackets to size and design shown.
5. Exterior Post Anchors.
   a. Fabricate tube or pipe sleeves with closed ends or plates as shown.
   b. Where inserts interfere with reinforcing bars, provide flanged fittings welded or threaded to posts for securing to concrete with expansion bolts.
   c. Provide heavy pattern sliding flange base plate with set screws at base of pipe or tube posts. Base plates are not required on pipe sleeves where ornamental railings occur.
6. Interior Post Anchors:
   a. Provide flanged fittings for securing fixed posts to floor with expansion bolts, unless shown otherwise.
   b. Weld or thread flanged fitting to posts at base.
   c. For securing removable posts to floor, provide close fitting sleeve insert or inverted flange base plate with stud bolts or rivets concrete anchor welded to the base plate.
   d. Provide sliding flange base plate on posts secured with set screws.
   e. Weld flange base plate to removable posts set in sleeves.

C. Handrails:
  1. Close free ends of rail with flush metal caps welded in place except where flanges for securing to walls with bolts are shown.
  2. Make provisions for attaching handrail brackets to wall, posts, and handrail as shown.

D. Steel Pipe Railings:
  1. Fabricate of steel pipe with welded joints.
  2. Number and space of rails as shown.
  3. Space posts for railings not over 1800 mm (6 feet) on centers between end posts.
  4. Form handrail brackets from malleable iron.
  5. Fabricate removable sections with posts at end of section.
  6. Removable Rails:
     a. Provide "U" shape brackets at each end to hold removable rail as shown. Use for top and bottom horizontal rail when rails are joined together with vertical members.
     b. Secure rail to brackets with 9 mm (3/8 inch) stainless steel through bolts and nuts at top rail only when rails joined with vertical members.
     c. Continuously weld brackets to post.
     d. Provide slotted bolt holes in rail bracket.
     e. Weld bolt heads flush with top of rail.
     f. Weld flanged fitting to post where posts are installed in sleeves.

2.14 CATWALKS

A. Fabricate catwalks including platforms, railings, ladders, supports and hangers, and arrangement of members as shown on drawings.

B. Fabricate stairs as specified in Section 05 51 00, METAL STAIRS.

C. Fabricate steel ladders as specified under paragraph LADDERS unless shown otherwise.

D. Fabricate steel pipe railings as specified under paragraph RAILINGS.

E. Catwalk and platforms floor surfaces as shown.
  1. Steel gratings as specified under paragraph gratings, either bar or plank type.
  2. Steel floor plate.
  3. Aluminum floor plate.

F. Prime paint catwalk system.

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. Items set into concrete or masonry.
  1. Provide temporary bracing for such items until concrete or masonry is set.
  2. Place in accordance with setting drawings and instructions.

3. Build strap anchors, into masonry as work progresses.

C. Set frames of gratings, covers, corner guards, trap doors and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.

D. Field weld in accordance with AWS.
   1. Design and finish as specified for shop welding.
   2. Use continuous weld unless specified otherwise.

E. 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.

F. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.

G. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.

H. Secure escutcheon plate with set screw.

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.
   4. Secure steel plate or hat channels to studs as detailed.

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. Fit modular channel unit flush with finish ceiling, and secure to plate with modular channel unit manufacturer's standard fittings through steel shims or spreaders as shown.
      a. Install closure plates in channel between eye bolts.
      b. Install eyebolts in channel.

I. Support for Communion Rail Posts:
   1. Anchor steel plate supports for posts as shown.

2. Use four bolts per plate, locate two at top and two at bottom.
3. Use lag bolts.

3.3 COVERS AND FRAMES FOR PITS AND TRENCHES

A. Set frame and cover flush with finish floor.

B. Secure plates to frame with flat head countersunk screws.

C. Set gratings loose in drainage trenches or over pits unless shown anchored.

3.4 OTHER FRAMES

A. Set frame flush with surface unless shown otherwise.

B. Anchor frames at ends and not over 450 mm (18 inches) on centers unless shown otherwise.

C. Set in formwork before concrete is placed.

3.7 GUARDS

A. Channel Guard at Top Edge of Concrete Platforms:
1. Install in formwork before concrete is placed.
2. Set channel flush with top of the platform.

3.8 GRATINGS

A. Set grating flush with finish floor; top of curb, or areaway wall. Set frame so that horizontal leg of angle frame is flush with face of wall except when frame is installed on face of wall.

B. Set frame in formwork before concrete is placed.

C. Where grating terminates at a wall bolt frame to concrete or masonry with expansion bolts unless shown otherwise.

D. Secure removable supporting members in place with stainless steel bolts.

E. Bolt gratings to supports.

3.9 SHELF ANGLES

A. Anchor shelf angles with 19 mm (3/4 inch) bolts unless shown otherwise in adjustable malleable iron inserts, set level at elevation shown.

B. Provide expansion space at end of members.

3.11 LADDERS

A. Anchor ladders to walls and floors with expansion bolts through turned lugs or angle clips or brackets.

B. In elevator pits, set ladders to clear all elevator equipment where shown on the drawings.
1. Where ladders are interrupted by division beams, anchor ladders to beams by welding, and to floors with expansion bolts.
2. Where ladders are adjacent to division beams, anchor ladders to beams with bent steel plates, and to floor with expansion bolts.

C. Ladder Rungs:
1. Set ladder rungs into formwork before concrete is placed.
2. Set step portion of rung 150 mm (6 inches) from wall.

3. Space rungs approximately 300 mm (12 inches) on centers.
4. Where only one rung is required, locate it 400 mm (16 inches) above the floor.

3.10 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 concrete or solid masonry with machine screws through flanged fitting to steel plate.
      a. Anchor steel plate to concrete or solid masonry with expansion bolts.
   2. Anchor flanged fitting with toggle bolt to steel support in frame walls.

D. Removable Rails:
   1. Rest rails in brackets at each end and secure to bracket with stainless steel bolts and nuts where part of a continuous railing.
   2. Rest rail posts in sleeves where not part of a continuous railing. Do not grout posts.

E. Handrails:
   1. Anchor brackets for metal handrails as detailed.
   2. Install brackets within 300 mm (12 inches) of return of walls, and at evenly spaced intermediate points not exceeding 1200 mm (4 feet) on centers unless shown otherwise.
   3. Expansion bolt to concrete or solid masonry.
   4. Toggle bolt to installed supporting frame wall and to hollow masonry unless shown otherwise.

3.11 CATWALK AND PLATFORMS

A. Expansion bolt members to concrete unless shown otherwise.
B. Bolt or weld structural components together including ladders and stairs to support system.
C. Weld railings to structural framing.
D. Bolt or weld walk surface to structural framing.
E. Smooth field welds and spot prime damaged prime paint surface.

F. Fasten removable members with stainless steel fasteners.

3.12 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.

- - - E N D - - -

SECTION 05 51 00
METAL STAIRS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section specifies steel stairs with railings.

B. Types:

1. Industrial stairs: Open riser stairs

1.2 RALATED WORK

A. Wall handrails and railings for other than steel stairs: Section 05 50 00, METAL FABRICATIONS.

B. Requirements for shop 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. Shop Drawings: Show design, fabrication details, installation, connections, material, and size of members.

1.4 APPLICATION 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.

B. American Society for Testing and Materials (ASTM):

A36/A36M-08 ....Structural Steel

A47-99 (R2009)..........................Ferritic Malleable Iron Castings

A48-03(R2008)...........................Gray Iron Castings

A307-10.....................................Carbon Steel Bolts and Studs, 60000 psi Tensile Strength

A653/653M-10............................Steel Sheet, Zinc Coated (Galvanized) or Zinc Alloy Coated (Galvannealed) by the Hot-Dip Process

A563-07.....................................Carbon and Alloy Steel Nuts

A786/A786M-09 ....Rolled Steel Floor Plates

C. American Welding Society (AWS):

D1.1-10 ....Structural Welding Code-Steel

D1.3-08 ....Structural Welding Code-Sheet Steel

D. The National Association of Architectural Metal Manufactures (NAAMM) Manuals:

Metal Bar Gratings (ANSI/NAAMM MBG 531-09)

AMP521-01 ....Pipe Railing Manual, Including Round Tube

E. American Iron and Steel Institute (AISI):

2001 ....Design of Cold-Formed Steel Structural Members

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Design stairs to support a live load of 500 kg/m^2 (100 pounds per square foot).

B. Structural design, fabrication and assembly in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.

C. Design Grating treads in accordance with NAAMM Metal Bar Grating Manual.

D. Design pipe railings in accordance with NAAMM Pipe Railing Manual for 900 N (200 pounds) in any direction at any point.

2.2 MATERIALS

A. Steel Grating: Metal bar type grating NAAMM BG

B. Structural Steel: ASTM A36

C. Steel Floor Plate: ASTM 786

D. Steel Decking: Form from zinc coated steel conforming to ASTM A446, with properties conforming to AISI Specification for the Design of Cold-Formed Steel Structural Members.

E. Iron Castings: ASTM A48, Class 30

R. Malleable Iron Castings: ASTM A47

2.3 FABRICATION GENERAL

A. Fasteners:
   1. Conceal bolts and screws wherever possible.
   2. Use countersunk heads on exposed bolts and screws with ends of bolts and screws dressed flush after nuts are set.

B. Welding:
   1. Structural steel, AWS D1.1 and sheet steel, AWS D1.3.
   2. Where possible, locate welds on unexposed side.
   3. Grind exposed welds smooth and true to contour of welded member.
   4. Remove welding splatter.

C. Remove sharp edges and burrs.

D. Fit stringers to head channel and close ends with steel plates welded in place where shown.

E. Fit face stringer to newel post by tenoning into newel post, or by notching and fitting face stringer to side of newel where shown.

F. Shop Prime Painting: Prepare surface and apply primer as specified for ferrous metals in Section 09 91 00, PAINTING.

2.4 RAILINGS

A. Fabricate railings, including handrails, from steel pipe with flush.
   1. Connections may be standard fittings designed for welding, or coped or mitered pipe with full welds.
   2. Wall handrails are provided under Section 05 50 00, METAL FABRICATIONS.

B. Return ends of handrail to wall and close free end.

C. Provide standard terminal castings where fastened to newel.

D. Space intermediate posts not over 1500 mm (5 feet) on center between end post or newel post.

E. Fabricate handrail brackets from cast malleable iron.

F. Provide standard terminal fittings at ends of post and rails.

2.5 INDUSTRIAL STAIRS

A. Provide treads, platforms, railings, stringers and other supporting members as shown.

B. Treads and platforms of checkered steel floor plate:

1. Turn floor plate down to form nosing on treads and edge of platform at head of stairs.
2. Support tread and platforms with angles welded to plate.
3. Do not leave exposed fasteners on top of treads or platform surfaces.

C. Treads and platforms of steel grating:

1. Fabricate steel grating treads and platforms in accordance with requirements of NAAMM Metal Bar Grating Manuals.
2. Provide end banding bars, except where carrier angle are used at tread ends.
3. Support treads by use of carrier plates or carrier angle. Use carrier plate end banding bars on exterior stairs.
4. Provide abrasive nosing on treads and edge of platforms at head of stairs.
5. Provide toe plates on platforms where shown.

PART 3 - EXECUTION

3.1 STAIR INSTALLATION

A. Provide hangers and struts required to support the loads imposed.

B. Perform job site welding and bolting as specified for shop fabrication.

C. Set stairs and other members in position and secure to structure as shown.

D. Install stairs plumb, level and true to line.

E. Provide steel closure plate to fill any gap between the stringer and surrounding shaft wall. Weld and finish with prime and paint finish of adjoining steel.

3.2 RAILING INSTALLATION

A. Install standard terminal fittings at ends of posts and rails.

B. Secure brackets, posts and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.

C. Set rails horizontal or parallel to rake of stairs to within 3 mm in 3650 mm (1/8-inch in 12 feet).

D. Set posts plumb and aligned to within 3 mm in 3650 mm (1/8-inch in 12 feet).

3.3 FIELD PRIME PAINTING

A. When installation is complete, clean field welds and surrounding areas to bright metal, and coat with same primer paint used for shop priming.

B. Touch-up abraded areas with same primer paint used for shop priming.

C. Touch up abraded galvanized areas as specified in section 09 91 00, PAINTING.

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies wood blocking, framing, sheathing, furring, nailers, sub-flooring, rough hardware, and light wood construction.

1.2 RELATED WORK:

A. Sustainable design requirements: Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS

B. Roof deck and insulation: Section 07 22 00, ROOF DECK AND INSULATION

C. Modified Bituminous Membrane Roofing: Section 07 52 00, MODIFIED BITUMINOUS MEMBRANE ROOF, COLD APPLIED

1.3 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Postconsumer and preconsumer recycled content as specified in PART 2 - PRODUCTS
2. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS

C. Shop Drawings showing framing connection details, fasteners, connections and dimensions.

D. Manufacturer’s Literature and Data:

1. Submit data for lumber, panels, hardware and adhesives.
2. Submit data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plants that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
3. Submit data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
4. For products receiving a waterborne treatment, submit statement that moisture content of treated materials was reduced to levels specified before shipment to project site.

E. Manufacturer’s certificate for unmarked lumber.

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 152 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 QUALITY ASSURANCE:

A. Installer: A firm with a minimum of three (3) years' experience in the type of work required by this section.

1.6 GRADING AND MARKINGS:

A. Any unmarked lumber or plywood panel for its grade and species will not be allowed on VA Construction sites for lumber and material not normally grade marked, provide manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material meet the specified the specified requirements.

1.7 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):

NDS-15 ....National Design Specification for Wood Construction
WCD1-01 ....Details for Conventional Wood Frame Construction

C. American Institute of Timber Construction (AITC):

A190.1-07..................................Structural Glued Laminated Timber

D. American Society of Mechanical Engineers (ASME):

B18.2.1-12(R2013)....................Square and Hex Bolts and Screws
B18.2.2-10.................................Square and Hex Nuts
B18.6.1-81(R2008)....................Wood Screws

E. American Plywood Association (APA):

E30-11.......................................Engineered Wood Construction Guide

F. ASTM International (ASTM):

A653/A653M-13 ....Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process
C954-11 ....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
C1002-14 ....Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs
D198-14 ....Test Methods of Static Tests of Lumber in Structural Sizes
D2344/D2344M-13.....................Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
D2559-12a ....Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions

D3498-03(R2011) ....Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems

F844-07a(R2013)......................Washers, Steel, Plan (Flat) Unhardened for General Use

F1667-13...................................Nails, Spikes, and Staples

G. American Wood Protection Association (AWPA):

AWPA Book of Standards

H. Commercial Item Description (CID):

A-A-55615 ....Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)

I. Forest Stewardship Council (FSC):

FSC-STD-01-001(Ver. 4-0)……..FSC Principles and Criteria for Forest Stewardship

J. Military Specification (Mil. Spec.):

MIL-L-19140E ....Lumber and Plywood, Fire-Retardant Treated

K. Environmental Protection Agency (EPA):

40 CFR 59(2014) ....National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

M. U.S. Department of Commerce Product Standard (PS)

PS 1-95 ....Construction and Industrial Plywood

PS 20-10 ....American Softwood Lumber Standard

N. ICC Evaluation Service (ICC ES):

AC09 ....Quality Control of Wood Shakes and Shingles

AC174 ....Deck Board Span Ratings and Guardrail Systems (Guards and Handrails)

PART 2 - PRODUCTS

2.1 LUMBER:

A. Unless otherwise specified, each piece of lumber must bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
   1. Identifying marks are to be 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. Structural Members: Species and grade as listed in the AFPA NDS having design stresses as shown.

C. 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. Framing lumber: Minimum extreme fiber stress in bending of 7584 kPa (1100 PSI).
3. Furring, blocking, nailers and similar items 101 mm (4 inches) and narrower Standard Grade; and, members 152 mm (6 inches) and wider, Number 2 Grade.

D. Sizes:
1. Conforming to PS 20.
2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.

E. Moisture Content:
1. Maximum moisture content of wood products is to be as follows at the time of delivery to site.
   a. Boards and lumber 50 mm (2 inches) and less in thickness: 19 percent or less.
   b. Lumber over 50 mm (2 inches) thick: 25 percent or less.

F. Fire Retardant Treatment:
1. Comply with Mil Spec. MIL-L-19140.
2. Treatment and performance inspection, by an independent and qualified testing agency that establishes performance ratings.

G. 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 of open roofed structures; sills, sole plates, furring, and sleepers that are less than 610 mm (24 inches) from ground; nailers, edge strips, blocking, crickets, curbs, cants, vent strips and other members provided in connection with roofing and flashing materials.
3. Treat other members specified as preservative treated (PT).
4. Preservative treat by the pressure method complying with AWPA Book use category system standards U1 and T1, except any process involving the use of Chromated Copper Arsenate (CCA) or other agents classified as carcinogenic for pressure treating wood is not permitted.

2.2 PLYWOOD:

A. Comply with 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. Sheathing:
1. APA rated Exposure 1 or Exterior; panel grade CD or better.
2. Wall sheathing:
   a. Minimum 9 mm (11/32 inch) thick with supports 406 mm (16 inches) on center and 12 mm (15/32 inch) thick with supports 610 mm (24 inches) on center unless specified otherwise.

b. Minimum 1200 mm (48 inches) wide at corners without corner bracing of framing.

3. Roof sheathing:
   a. Minimum 9 mm (11/32 inch) thick with span rating 24/0 or 12 mm (15/32 inch) thick with span rating for supports 406 mm (16 inches) on center unless specified otherwise.
   b. Minimum 15 mm (19/32 inch) thick or span rating of 40/20 or 18 mm (23/32 inch) thick or span rating of 48/24 for supports 610 mm (24 inches) on center.

D. Subflooring:
1. Under finish wood flooring or underlayment:
   a. APA Rated sheathing, Exposure 1. panel grade CD.
   b. Minimum 15 mm (19/32 inch) thick with span rating 32/16 or greater for supports at 406 mm (16 inches) on center and 18.25 mm (23/32 inch) thick with span rating 48/24 for supports at 610 mm (24 inches) on center.
2. Combination subflooring-underlayment under resilient flooring or carpet:
   a. APA Rated Stud-I-Floor Exterior or Exposure 1, T and G.
   b. Minimum 15 mm (19/32 inch) thick or greater, span rating 16, for supports at 406 mm (16 inches) on center; 18 mm (23/32 inch) thick or greater, span rating 24, for supports at 610 mm (24 inches) on center.

E. Underlayment:
1. APA rated Exposure 1 or Exterior, panel grade C-C Plugged.
2. Minimum 6 mm (1/4 inch) thick or greater over plywood subflooring unless otherwise shown.

2.3 STRUCTURAL-USE PANELS:

A. Comply with APA E30.

B. Bearing the mark of a recognized association or independent agency that maintains continuing control over quality of panel which identifies compliance by end use, Span Rating, and exposure durability classification.

C. Wall and Roof Sheathing:
1. APA Rated sheathing panels, durability classification of Exposure 1 or Exterior Span Rating of 16/0 or greater for supports 406 mm (16 inches) on center and 24/0 or greater for supports 610 mm (24 inches) on center.

D. Subflooring:
1. Under underlayment:
   a. APA rated sheathing panels, durability classification of Exposure 1 or Exterior.
   b. Span Rating of 24/16 or greater for supports 406 mm (16 inches).
2. Under resilient floor.
   a. APA rated combination subfloor-underlayment grade panels, durability classification of Exposure 1 or Exterior T and G.

b. Span Rating of 16 or greater for supports 406 mm (16 inches) on center and 24 or greater for supports 610 mm (24 inches) on center.

E. Underlayment:

1. APA rated Exposure l
2. Minimum 6 mm (1/4 inch) thick or greater over subfloor.

F. Laminated Veneer Lumber (LVL):

1. Bonded jointed wood veneers with ASTM D2559 adhesive
2. Scarf jointed wood veneers with grain of wood parallel
3. Size as indicated on contract documents.

2.4 ROUGH HARDWARE AND ADHESIVES:

A. Anchor Bolts:

1. ASME B18.2.1 and ASME B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
2. Extend at least 203 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. Provide 13 mm (1/2 inch) bolt unless shown otherwise.

C. Washers

1. ASTM F844
2. Provide zinc or cadmium coated steel or cast iron for washers exposed to weather.

D. Screws:

1. Wood to Wood: ASME B18.6.1 or ASTM C1002
2. Wood to Steel: ASTM C954, or ASTM C1002

E. Nails:

1. Size and type best suited for purpose unless noted otherwise. Provide aluminum-alloy nails, plated nails, or zinc-coated nails, for nailing wood work exposed to weather and on roof blocking.
2. ASTM F1667:
   a. Common: Type I, Style 10
   b. Concrete: Type I, Style 11
   c. Barbed: Type I, Style 26
   d. Underlayment: Type I, Style 25
   e. Masonry: Type I, Style 27
   f. Provide special nails designed for use with ties, strap anchors, framing connectors, joists hangers, and similar items. Nails not less than 32 mm (1-1/4 inches) long, 8d and deformed or annular ring shank.

F. Framing and Timber Connectors:

1. Fabricate of ASTM A653/A653M, Grade A; steel sheet not less than 1.3 mm (0.052 inch) thick unless specified otherwise. Apply standard plating to steel timber connectors after punching, forming and assembly of parts.
2. Framing Angles: Angle designed with bendable legs to provide three (3) way anchors.
3. Straps:
   a. Designed to provide wind and seismic ties with sizes as shown or specified.
   b. Strap ties not less than 32 mm (1-1/4 inches) wide
   c. Punched for fastener.
4. Joist Hangers:
   a. Fabricated of 1.6 mm (0.063 inch) minimum thick sheet, U design unless shown otherwise.
   b. Heavy duty hangers fabricated of minimum 2.7 mm (0.108 inch) thick sheet, U design with bent top flange to lap over beam.
5. Timber Connectors: Fabricated of steel to shapes indicated on contract drawings.
6. Joist Ties: Mild steel flats, 5 mm by 32 mm (3/16 inch by 1-1/4 inch) size with ends bent about 30 degrees from horizontal, and extending at least 406 mm (16 inches) onto framing. Punch each end for three (3) spikes.
7. Wall Anchors for Joists and Rafters:
   a. Mild steel strap, 5 mm by 32 mm (3/16 inch by 1-1/4 inch) with wall ends bent 50 mm (2 inches), or provide 9 mm by 130 mm (3/8 inch by 5 inch) pin through strap end built into masonry.
   b. Strap long enough to extend onto three joists or rafters, and punched for spiking at each bearing.
   c. Strap not less than 101 mm (4 inches) embedded end.

G. Adhesives:
1. For field-gluing plywood to lumber framing floor or roof systems: ASTM D3498
2. For structural laminated wood: ASTM D2559
3. Adhesives to have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLATION OF FRAMING AND MISCELLANEOUS WOOD MEMBERS:

A. Conform to applicable requirements of the following:
1. AFPA NDS for timber connectors
2. AFPA WCD1 for nailing and framing unless specified otherwise.
3. APA for installation of plywood or structural use panels.

B. Fasteners:
1. Nails

a. Nail in accordance with the Recommended Nailing Schedule as specified in AFPA WCD1 where detailed nailing requirements are not specified in nailing schedule. Select nail size and nail spacing sufficient to develop adequate strength for the connection without splitting the members.

b. Use special nails with framing connectors.

c. For sheathing and subflooring, select length of nails sufficient to extend 25 mm (1 inch) into supports.

d. Use 8d or larger nails for nailing through 25 mm (1-inch) thick lumber and for toe nailing 50 mm (2 inch) thick lumber.

e. Use 16d or larger nails for nailing through 50 mm (2-inch) thick lumber.

f. Select the size and number of nails in accordance with the Nailing Schedule except for special nails with framing anchors.

g. Nailing Schedule; Using Common Nails:

   1) Joist bearing on sill or girder, toe nail three (3) 8d nails or framing anchor.

   2) Bridging to joist, toe nail each end two (2) 8d nails.

   3) Ledger strip to beam or girder three (3) 16d nails under each joint.

   4) Subflooring or Sheathing:

      a) 152 mm (6 inch) wide or less to each joist face nail two (2) 8d nails.

      b) Subflooring, more than 152 mm (6 inches) wide, to each stud or joint, face nail three (3) 8d nails.

      c) Plywood or structural use panel to each stud or joist face nail 8d, at supported edges 152 mm (6 inches) on center and at intermediate supports 254 mm (10 inches) on center. When gluing plywood to joint framing increase nail spacing to 305 mm (12 inches) at supported edges and 508 mm (20 inches) o.c. at intermediate supports.

   5) Sole plate to joist or blocking, through sub floor face nail 20d nails, 406 mm (16 inches) on center.

   6) Top plate to stud, end nail two (2) 16d nails.

   7) Stud to sole plate, toe nail or framing anchor. Four (4) 8d nails.

   8) Doubled studs, face nail 16d at 610 mm (24 inches) on center.

   9) Built-up corner studs 16d at 610 mm (24 inches) (24 inches) on center.

   10) Doubled top plates, face nails 16d at 406 mm (16 inches) on center.

   11) Top plates, laps, and intersections, face nail two (2) 16d.

   12) Continuous header, two pieces 16d at 406 mm (16 inches) on center along each edge.

   13) Ceiling joists to plate, toenail three (3) 8d or framing anchor.

   14) Continuous header to stud, four (4) 16d.

15) Ceiling joists, laps over partitions, face nail three (3) 16d or framing anchor.
16) Ceiling joists, to parallel rafters, face nail three (3) 16d.
17) Rafter to plate, toe nail three (3) 8d or framing anchor. Brace 25 mm (1 inch) thick board to each stud and plate, face nail three (3) 8d.

2. 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 and solid masonry or provide expansion bolts. Special bolts or screws designed for anchor to solid masonry or concrete in drilled holes may be used.
   d. Provide toggle bolts to hollow masonry or sheet metal.
   e. Provide 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 610 mm (24 inch) intervals between end bolts. Provide clips to beam flanges.
3. 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 C954 for steel over 0.84 mm (0.033 inch) thick.
4. Power actuated drive pins may be provided where practical to anchor to solid masonry, concrete, or steel.
5. Do not anchor to wood plugs or nailing blocks in masonry or concrete. Provide metal plugs, inserts or similar fastening.
6. Screws to Join Wood:
   a. Where shown or option to nails.
   b. ASTM C1002, sized to provide not less than 25 mm (1 inch) penetration into anchorage member.
   c. Spaced same as nails.
7. Installation of Timber Connectors:
   a. Conform to applicable requirements of the AFPA NDS.
   b. Fit wood to connectors and drill holes for fasteners so wood is not split.

C. Set sills or plates level in full bed of mortar on masonry or concrete walls.
   1. Space anchor bolts 1219 mm (4 feet) on centers between ends and within 152 mm (6 inches) of end. Stagger bolts from side to side on plates over 178 mm (7 inches) in width.
   2. Provide shims of slate, tile or similar approved material to level wood members resting on concrete or masonry. Do not use wood shims or wedges.
   3. Closely fit, and set to required lines.

D. Cut notch, or bore in accordance with AFPA WCD1 passage of ducts, wires, bolts, pipes, or conduits and to accommodate other work. Repair or replace miscut, misfit, or damaged work.

E. Blocking Nailers, and Furring:

1. Install furring, blocking, nailers, and grounds where shown.
2. Provide longest lengths practicable.
3. Provide 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 610 mm (24 inches) between ends.
   c. Stagger nails from side to side of wood member over 127 mm (5 inches) in width.
5. Where shown, provide wall furring 25 mm by 75 mm (1 inch by 3 inch) continuous wood strips installed plumb on walls, using wood shims where necessary so face of furring forms a true, even plane. Space furring not over 406 mm (16 inches) on centers, butt joints over bearings and rigidly secure in place. Anchor furring on 406 mm (16 inches) centers.

F. Floor and Ceiling Framing:
1. Set with crown edge up.
2. Keep framing at least 50 mm (2 inches) away from chimneys or heat producing appliances.
3. Bear on not less than 101 mm (4 inches) on concrete and masonry, and 38 mm (1-1/2 inches) on wood and metal unless shown otherwise.
4. Support joist, trimmer joists, headers, and beams framing into carrying members at same relative levels on joist hangers unless shown otherwise.
5. Lap and spike wood joists together at bearing, or butt end-to-end with scab ties at joint and spike to plates. Scab tie lengths not less than 203 mm (8 inches) lap on joist ends. Install wood I beam joists as indicated in contract documents.
6. Frame openings with headers and trimmer joist. Double headers carrying more than two tail joists and trimmer joists supporting headers carrying more than one tail joist unless otherwise indicated in contract documents.
7. Drive nails through headers into joists using two (2) nails for 50 mm by 152 mm (2 inch by 6 inch); three (3) nails for 50 mm by 203 mm (2 inch by 8 inch) and four (4) nails for 50 mm by 254 mm (2 inch by 10 inch) and over in size.
8. Install nearest joist to double headers and spike joist to both header members before trimmer joist is installed and secured together.
9. Doubled joists under partitions parallel with floor joists. Fire cut joists built into masonry or concrete.
10. Where joists run perpendicular to masonry or concrete, anchor every third joist to masonry or concrete with one (1) metal wall anchor. Securely spike anchors with three (3) nails to side of joist near its bottom.
11. Anchor joists running parallel with masonry or concrete walls to walls with steel flats spaced not over 1828 mm (6 feet) apart. Extend steel flats over at least three (3) joists and into

masonry 101 mm (4 inches) with ends turned 50 mm (2 inches); bolt to concrete. Set top of flats flush with top of joists, and securely nail steel flats to each joist.

12. Hook ties at steel framing over top flange of steel members.
13. Nonbearing partitions running parallel with ceiling joists, install solid 50 mm (2 inch) thick bridging same depth as ceiling joists cut to fit snug between joists for securing top plate of partitions. Securely spike bridging to joists. Space 1219 mm (4 feet) on center.
14. Where ceramic tile finish floors are set in Portland cement mortar, nail continuous 50 mm by 75 mm (2 inches by 3 inches) ledgers to sides of joists to support subflooring flush with top of joist.

G. Roof Framing:

1. Set rafters with crown edge up.
2. Form a true plane at tops of rafters.
3. Valley, Ridge, and Hip Members:
    a. Size for depth of cut on rafters.
    b. Straight and true intersections of roof planes.
    c. Secure hip and valley rafters to wall plates by using framing connectors.
    d. Double valley rafters longer than the available lumber, with pieces lapped not less than 1219 mm (4 feet) and spiked together.
    e. Butt joint and scab hip rafters longer than the available lumber.
4. Spike to wall plate and to ceiling joists except when secured with framing connectors.
5. Frame openings in roof with headers and trimmer rafters. Double headers carrying more than one (1) rafter unless shown otherwise.
6. Install 50 mm by 101 mm (2 inch by 4 inch) strut between roof rafters and ceiling joists at 1219 mm (4 feet) on center unless shown otherwise.

H. Partition and Wall Framing:

1. Provide 50 mm by 101 mm (2 inch by 4 inch) studs spaced 406 mm (16 inches) on centers; unless otherwise indicated on contract documents.
2. Install double studs at openings and triple studs at corners.
3. Installation of sole plate:
    a. Anchor plates of walls or partitions resting on concrete floors in place with expansion bolts, one (1) near ends of piece and at intermediate intervals of not more than 1219 mm (4 feet) or with power actuated drive pins with threaded ends of suitable type and size, spaced 610 mm (2 feet) on center unless shown otherwise.
    b. Nail plates to wood framing through subfloor as specified in nailing schedule.
4. Headers or Lintels:

a. Make headers for openings of two (2) pieces of 50 mm (2 inch) thick lumber of size shown with plywood filler to finish flush with face of studs or solid lumber of equivalent size.

b. Support ends of headers on top of stud cut for height of opening. Spike cut stud to adjacent stud. Spike adjacent stud to header.

5. Provide double top plates, with members lapped at least 610 mm (2-feet) spiked together.

6. Install intermediate cut studs over headers and under sills to maintain uniformity of stud spacing.

7. Provide single sill plates at bottom of opening unless otherwise indicated in contract documents. Toe nail to end stud, face nail to intermediate studs.

8. Install 50 mm (2 inch) blocking for firestopping so that maximum dimension of any concealed space is not over 2438 mm (8 feet) in accordance with AFPA WCD1.

9. Install corner bracing when plywood or structured use panel sheathing is not used.

   a. Let corner bracing into exterior surfaces of studs at an angle of approximately 45 degrees, extended completely over walls plates, and secured at bearing with two (2) nails.

   b. Provide 25 mm by 101 mm (1 inch by 4 inch) corner bracing.

I. Subflooring:

1. Subflooring may be either boards, structural-use panels, or plywood.

2. Lay board subflooring diagonally, with close joints. Stagger end joints and make joints over supports. Bear each board on at least three supports.

3. Provide a clearance of approximately 13 mm (1/2 inch) at masonry or concrete at walls.

4. Apply plywood and structural-use panel subflooring with face grain or long dimension at right angles to the supports, with edges 6 mm (1/4 inch) apart at side joints, and 3 mm (1/8 inch) apart at end joints.

5. Combination subfloor-underlayment:

   a. Space edges 3 mm (1/8 inch) apart.

   b. Provide a clearance of 6 mm (1/4 inch) at masonry on concrete at walls.

6. Stagger panel end joints and make over support.

J. Underlayment:

1. Where finish flooring of different thickness is used in adjoining areas, provide underlayment of thickness required to bring finish-flooring surfaces into same plane.

2. Apply to dry, level, securely nailed, clean, wood subfloor without any projections.

3. Plywood and particle underlayment are to be glue-nailed to subfloor.

4. Butt underlayment panels to a light contact with a 1 mm (1/32 inch) space between plywood or hardboard underlayment panels and walls, and approximately 9 mm (3/8 inch) between particleboard underlayment panels and walls.

5. Stagger underlayment panel end joints with respect to each other and offset joints with respect to joints in the subfloor at least 50 mm (2 inches).
6. After installation, avoid traffic on underlayment and damage to the finish surface.

K. Sheathing:

1. Provide plywood or structural-use panels for sheathing.
2. Lay panels with joints staggered, with edge and ends 3 mm (1/8 inch) apart and nailed over bearings as specified.
3. Set nails not less than 9 mm (3/8 inch) from edges.
4. Install 50 mm by 101 mm (2 inch by 4 inch) blocking spiked between joists, rafters and studs to support edge or end joints of panels.
5. Match and align sheathing which is an extension of work in place to existing.

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SECTION 07 01 50.19
PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Roof tear-off,partial roof tear-off,temporary roofing membrane, on existing construction in preparation to receive new roofing membrane.

B. Existing Membrane Roofing System: Gravel Surface BUR roofing membrane, with related insulation, surfacing, and components and accessories between deck and roofing membrane.

1.2 RELATED WORK

A. Use of the premises and phasing requirements: Section 01 00 00 GENERAL REQUIREMENTS.

B. Temporary construction and environmental-protection measures for reroofing preparation: Section 01 00 00 GENERAL REQUIREMENTS

C. HVAC equipment removal and reinstallation: Division 23 sections.

D. Electrical equipment disconnection and reconnection: Division 26 sections.

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):

ANSI/SPRI FX-1-01(R2006) ......Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.

C. ASTM International (ASTM):

C208-08 ....Cellulosic Fiber Insulating Board

C728-05 ....Perlite Thermal Insulation Board

C1177/C1177M-08.....................Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

C1278/C1278M-07.....................Standard Specification for Fiber-Reinforced Gypsum Panel

D1079-09 ....Standard Terminology Relating to Roofing and Waterproofing

D. FM Approvals: RoofNav Approved Roofing Assemblies and Products.

4450-89 ....Approved Standard for Class 1 Insulated Steel Deck Roofs

4470-10 ....Approved Standard for Class 1 Roof Coverings

1-28-09......................................Loss Prevention Data Sheet: Design Wind Loads.

1-29-09......................................Loss Prevention Data Sheet: Above-Deck Roof Components

1-49-09......................................Loss Prevention Data Sheet: Perimeter Flashing

E. National Roofing Contractors Association: Roofing and Waterproofing Manual

1.4 MATERIALS OWNERSHIP

A. Assume ownership of demolished materials and remove from Project site and dispose of legally, unless indicated to be reused, reinstalled, or otherwise to remain Owner's property.

1.5 DEFINITIONS

A. Refer to ASTM D1079 and NRCA "The NRCA Roofing and Waterproofing Manual" for definition of terms.

1.6 QUALITY CONTROL

A. Requirements of Division 07 roofing section for qualifications of roofing system and roofing insulation Installer; work of this section shall be performed by same Installer.
   1. Where Project requirements include removal of asbestos-containing material, Installer must be legally qualified to perform the required work.
   2. Where Project requirements include work affecting existing roofing system to remain under warranty, Installer must be approved by warrantor of existing roofing system.

B. Regulatory Requirements: Comply with governing EPA notification regulations. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Reroofing Conference: Conduct conference at Project site.
   1. Meet with Owner; Architect-Engineer; testing and inspecting agency representative; roofing system manufacturer's representative; roofing Installer including project manager, superintendent, and foreman; and installers whose work interfaces with or affects reroofing.
   2. Review methods and procedures related to roofing system tear-off and replacement

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturer's Literature and Data:
   1. Recover boards.

C. List of proposed infill materials.

D. List of proposed temporary roofing materials.

E. Fastener pull-out test report.

F. Photographs or Videotape: Document existing conditions of adjacent construction including site improvements.

G. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a licensed landfill facility.

H. Qualification Data: For Installer.
   1. Certificate indicating Installer is licensed to perform asbestos abatement.
   2. Certificate indicating Installer is approved by warrantor of existing roofing system.

1.8 PROJECT CONDITIONS

A. Owner will occupy portions of building below reroofing area. Conduct reroofing so Owner's operations will not be disrupted.
   1. Coordinate work activities daily with Owner.
   2. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.

B. Protect building and landscaping from damage.

C. Maintain access to existing walkways and adjacent occupied facilities.

D. Available Information: The following are available for Contractor reference:
   1. Roof Moisture Survey of existing membrane roofing system.
   2. Analysis of test cores from existing membrane roofing system.
   3. Construction Drawings and Project Manual for existing roofing system.
   4. Contractor is responsible for interpretation and conclusions based upon available information.

E. Weather Limitations: Proceed with reroofing preparation only when weather conditions permit Work to proceed without water entering existing roofing system or building.

F. Hazardous Materials: It is not expected that Contractor will encounter hazardous materials such as asbestos-containing materials.
   1. Owner will remove hazardous materials before start of the Work.
   2. Do not disturb materials suspected of containing hazardous materials. Notify Architect-Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

G. Hazardous Materials: A report on the presence of hazardous materials is available to Contractor for review and use.
   1. Examine report to become aware of locations where hazardous materials are present.
   2. Hazardous material remediation is specified elsewhere in the Contract Documents.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces affected by reroofing, by methods and with materials acceptable to warrantor.
   1. Notify warrantor of existing roofing system before proceeding, and upon completion of reroofing.
   2. Obtain documentation verifying that existing roofing system has been inspected by warrantor and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 INFILL MATERIALS

A. Use infill materials matching existing membrane roofing system materials.

2.2 TEMPORARY ROOFING MATERIALS

A. Design of temporary roofing and selection of materials are responsibilities of Contractor.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing membrane roofing system that is indicated not to be reroofed.

1. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
2. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

B. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

1. Comply with Owner's requirements for maintaining fire watch when temporarily disabling smoke detectors.

C. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

D. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding.
2. Do not permit water to enter into or under existing membrane roofing system components that are to remain.

E. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

3.2 ROOF TEAR-OFF

A. General: Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.

B. Remove aggregate ballast from roofing membrane. Store aggregate ballast for reuse.

C. Remove loose aggregate from aggregate-surfaced built-up bituminous roofing using a power broom.

D. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse. Discard cracked pavers.

E. Remove protection mat and insulation from protected roofing membrane.

1. Discard insulation that is wet and exceeds 128 kg/cu. m (8 lb/cu. ft.).
2. Store insulation for reuse and protect from physical damage.

F. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.

Remove cover boards, roof insulation, and substrate boards.

1. Comply with FM Approvals requirements for removal of excess asphalt from steel decks.
2. Remove fasteners from deck or cut fasteners off slightly above deck surface and apply recover board prior to installing roof membrane.

G. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.

1. Remove roof insulation substrate boards.
2. Dry bitumen and felts that are firmly bonded to concrete decks may remain. Remove wet or unadhered bitumen and felts.
3. Comply with FM Approvals requirements for removal of excess asphalt from steel decks.
4. Remove fasteners from deck or cut fasteners off slightly above deck surface and apply recover board prior to installing roof membrane.

H. Partial Roof Tear-Off: Remove existing roofing membrane and immediately check for presence of moisture by visually observing cover boards, roof insulation, and substrate boards that will remain.

1. Coordinate with Owner's inspector to schedule times for tests and inspections immediately after membrane removal.
2. Remove wet or damp boards and roof insulation. Removal will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.
3. Remove fasteners from deck or cut fasteners off slightly above deck surface and apply recover board prior to installing roof membrane.

3.3 DECK PREPARATION

A. Inspect deck after tear-off or partial tear-off of membrane roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed or if deck appears or feels inadequately attached, immediately notify Architect-Engineer. Do not proceed with installation until directed by Architect-Engineer.

C. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Architect-Engineer. Do not proceed with installation until directed by Architect-Engineer.

D. Provide additional deck securement as indicated on Drawings.

E. Replace deck as indicated on Drawings. Replacement deck is specified in Section 00 00 00.

3.4 INFILL MATERIALS INSTALLATION

A. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.

1. Installation of infill materials is specified in Section 00 00 00.

2. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

3.5 TEMPORARY ROOFING MEMBRANE

A. Install approved temporary roofing membrane over area to be reroofed.

B. Remove temporary roofing membrane before installing new roofing membrane.

C. Prepare the temporary roof to receive new roofing membrane according to approved temporary roofing membrane proposal. Restore temporary roofing membrane to watertight condition. Obtain approval for temporary roof substrate from roofing membrane manufacturer and Architect-Engineer before installing new roof.

3.6 EXISTING BASE FLASHINGS

A. Remove existing base flashings around parapets, curbs, walls, and penetrations.

1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.

B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings specified in Section 07 60 00 SHEET METAL FLASHING AND TRIM.

C. Remove existing parapet sheathing and replace with new pressure-preservative, exterior fire-retardant-treated, plywood sheathing, 15 mm (19/32 inch) thick. If parapet framing has deteriorated, immediately notify Architect-Engineer.

3.7 FASTENER PULL-OUT TESTING

A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to Architect-Engineer before installing new membrane roofing system.

1. Obtain Architect-Engineer's approval to proceed with specified fastening pattern. Architect-Engineer may furnish revised fastening pattern commensurate with pull-out test results.

3.8 DISPOSAL

A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

1. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off Owner's property.

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SECTION 07 22 00
ROOF DECK AND INSULATION – PERMANENT ROOF

PART 1 — GENERAL

1.1 SUMMARY

A. Section includes roof insulation over the properly prepared deck substrate.

Scope of Work

1. Install rigid polyisocyanurate insulation and 12.7 mm (½ inch) asphalt saturated fiber board to achieve and R-value of 30.
2. Install insulation assembly per ASCE 7-5 building and site specific.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet and Strip
2. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process
3. ASTM B29 Standard Specification for Refined Lead
4. ASTM B32 Standard Specification for Solder Metal
5. ASTM C165 Standard Test Method for Measuring Compressive Properties of Thermal Insulation
6. ASTM C208 Standard Specification for Cellulosic Fiber Insulating Board
7. ASTM C209 Standard Test Method for Cellulosic Fiber Insulating Board
8. ASTM C272 Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
9. ASTM C1396 Standard Specification for Gypsum Wallboard
10. ASTM C518 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
11. ASTM C578 Standard Specification for Perlite Thermal Insulation Board
12. ASTM C728 Standard Test Methods for Fire Test of Roof Coverings
13. ASTM C1289 Standard Specification for Faced Rigid Polyisocyanurate Thermal Insulation
14. ASTM D5 Standard Test Method for Penetration of Bituminous Materials
15. ASTM D36 Standard Test Method for Softening Point of Bitumen (Ring and Ball Apparatus)
16. ASTM D312 Standard Specification for Asphalt Used in Roofing
17. ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension

18. ASTM D1621 Standard Test Method for Compressive Properties of Rigid Cellular Plastics
19. ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
20. ASTM D1863 Standard Specification for Mineral Aggregate Used on Built-Up Roofs
21. ASTM D2126 Standard Test Method for Response off Rigid Cellular Plastics to Thermal Humid Aging
22. ASTM D2178 Standard Specification for Asphalt Glass Felts used in Roofing and Waterproofing
23. ASTM D4601 Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
24. ASTM D5147 Standard Sampling and Testing Modified Bituminous Sheet Material.

B. Cast Iron Soil Pipe Institute, Washington, D.C. (CISPI)

C. Factory Mutual Research (FM):

1. Roof Assembly Classifications

D. National Roofing Contractors Association (NRCA):

1. Roofing and Waterproofing Manual

E. Underwriters Laboratories, Inc. (UL):

1. Fire Hazard Classifications

F. Warnock Hersey (WH):

1. Fire Hazard Classifications

G. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

H. Steel Deck Institute, St. Louis, Missouri (SDI)

I. Southern Pine Inspection Bureau, Pensacola, Florida (SPIB)

J. Insulation Board, Polyisocyanurate (FS HH-I-1972)

K. Insulation Board, Thermal (Fiberboard) (FS LLL-1-535B)

L. ASCE 7-5

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's specification data sheets for each product in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Provide approval letters from insulation manufacturer for use of their insulation within this particular roofing system type.

C. Provide a sample of each insulation type.

D. Shop Drawings:

1. Shop drawing shall include: Outline of roof, location of drains, complete board layout of tapered insulation components, thickness and the average "R" value for the completed insulation system.

E. Certification:

1. Submit roof manufacturer's certification that insulation fasteners furnished are acceptable to roof manufacturer.
2. Submit roof manufacturer's certification that insulation furnished is acceptable to roofing manufacturer as a component of roofing system and is eligible for roof manufacturer's system warranty.

1.4 QUALITY ASSURANCE

A. Fire Classification: ASTM E-108

B. Manufacturer's Certificate: Certify that roof system furnished is approved by Factory Mutual, Underwriters Laboratories, Warnock Hersey or approved third party testing facility in accordance with ASTM E108, Class A for external fire and meets local or nationally recognized building codes.

C. Manufacturer's Certificate: Certify that the roof system is adhered properly to meet or exceed the requirements of FM 1-90 and ASCE 7-5.

D. Pre-installation Meeting: Refer to Division 07 roofing specifications for pre-installation meeting requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site with seals and labels intact, in manufacturer's original containers, dry and undamaged.

B. Store all insulation materials in a manner to protect them from the wind, sun and moisture damage prior to and during installation. Any insulation that has been exposed to any moisture shall be removed from the project site.

C. Keep materials enclosed in a watertight, ventilated enclosure (i.e. tarpaulins).

D. Store materials off the ground. Any warped, broken or wet insulation boards shall be removed from the site.

PART 2 — PRODUCTS

2.1 PRODUCTS, GENERAL

A. Basis of Design: Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

B. Substitutions: Products proposed as equal to the products specified in this Section shall be submitted in accordance with Bidding Requirements and Division 01 provisions.

1. Proposals shall be accompanied by a copy of the manufacturer's standard specification section. That specification section shall be signed and sealed by a professional engineer licensed in the state in which the installation is to take place.

Substitution requests containing specifications without licensed engineer certification shall be rejected for non-conformance.

2. Include a list of three (3) projects of similar type and extent, located within a one hundred mile radius from the location of the project. In addition, the three projects must be at least five (5) years old and be available for inspection by the Architect, Owner or Owner's Representative.
3. Equivalency of performance criteria, warranty terms, submittal procedures, and contractual terms will constitute the basis of acceptance.
4. The Owner's decision regarding substitutions will be considered final. Unauthorized substitutions will be rejected.

2.2 INSULATION MATERIALS

A. Thermal Insulation Properties and Approved Insulation Boards.

1. Rigid Polyisocyanurate Roof Insulation; ASTM C1289:
   a. Qualities: Rigid, closed cell polyisocyanurate foam core bonded to heavy duty glass fiber mat facers.
   b. Thickness: Minimum140 mm (5-1/2 inches)
   c. R-Value: Minimum 30
   d. Compliances: UL, WH or FM listed under Roofing Systems
      Federal Specification HH-I-1972, Class 1
   e. Acceptable Products:
      1) ENRGY-3; Johns Manville
      2) Hytherm; Dow
      3) GAFTEMP Isotherm R; GAF
      4) Approved Equivalent
2. High Density Asphalt Saturated Fiberboard Roof Insulation; ASTM C208
   a. Qualities: Rigid, composed of interlocking fibers factory blended treated with asphalt.
   b. Board Size: 1219.2 x 1219.2 mm (4 x 4 feet)
   c. Thickness: Minimum 12.7 mm (½ inch)
   d. Compliances: UL, WH, FM listed under Roofing Systems. Federal Specification LLL-I-535-B
   e. Acceptable Manufacturers:
      1) Celotex
      2) Temple Inland
      3) GAF Building Materials Corporation
      4) Approved Equivalent
3. Tapered Perlite Roof Insulation Crickets; ASTM C728

a. Qualities: Rigid, Factory tapered perlite insulation board, uncoated.

b. Taper Thickness: Minimum 12.7 mm (½ inch) at low points.

c. Tapered Slope: Minimum 1:100 (1/8 inch per foot).

d. Average R-Value: Minimum 5.56.

e. Compliances: UL, WH, FM listed under Roofing Systems Federal Specification HH-I-529-B

f. Acceptable Manufacturers:

1) Celotex
2) Manville
3) GAF Building Materials Corporation
4) Approved Equivalent

2.3 RELATED MATERIALS

A. Fiber Cant and Tapered Edge Strips: Performed rigid insulation units of sizes/shapes indicated, matching insulation board or of perlite or organic fiberboard, as per the approved manufacturer.

1. Acceptable Manufacturers:

a. The Garland Company, Inc.

b. Celotex

c. Johns Manville

d. GAF

e. Approved Equivalent

B. Protection Board: Premolded semi-rigid asphalt saturated board one half (½) inch.

C. Roof Board Joint Tape: Six (6) inches wide glass fiber mat with adhesive compatible with insulation board facers.

D. Adhesive: ASTM D312, Green Lock zero VOC.

E. Roof Deck Insulation Adhesive: Single component, low rise foam adhesive as recommended by insulation manufacturer.

1. Tensile Strength (ASTM D412)……..1.723 MPa 250 psi)

2. Density (ASTM D1875)……………..8.5 lbs./gal.

3. Viscosity (ASTM D2556)…………..8,000 to 32,000 cP.

4. 2 `Peel Strength (ASTM D903)…………….17 lb/in.

5. 3 `Flexibility (ASTM D816)…………….Pass @ -56.7 degrees C (-70 degrees F)

F. Fasteners: Corrosion resistant screw fastener as recommended by roof membrane manufacturer.

1. Factory Mutual Tested and Approved with 76 mm (3 inches) coated disc for 1-90 rating, length required to penetrate metal deck 25 mm (1 inch).

PART 3 — EXECUTION

3.1 EXECUTION, GENERAL

A. Comply with requirements of Division 01 Section "Common Execution Requirements."

3.2 INSPECTION OF SURFACES

A. Roofing contractor shall be responsible for preparing an adequate substrate to receive insulation.

1. Verify that work which penetrates roof deck has been completed.
2. Verify that wood nailers are properly and securely installed.
3. Examine surfaces for defects, rough spots, ridges, depressions, foreign material, moisture, and unevenness.
4. Do not proceed until defects are corrected.
5. Do not apply insulation until substrate is sufficiently dry.
6. Broom clean substrate immediately prior to application.
7. Use additional insulation to fill depressions and low spots that would otherwise cause ponding water.
8. Verify that temporary roof has been completed.

3.3 INSTALLATION

A. Attachment with Mechanical Fasteners.

1. Approved insulation board shall be fully attached to the deck with an approved mechanical fastening system. As a minimum, the amount of fasteners shall be in accordance with manufacturer's recommendation for ASCE 7-5. Otherwise, a minimum of one fastener per two square feet shall be installed.
2. Filler pieces of insulation require at least two fasteners per piece if size of insulation is less than 0.37 square meters (4 square feet).
3. Spacing pattern of fasteners shall be as per manufacturer's recommendations to meet ASCE 7-5 requirements. Placement of any fastener from edge of insulation board shall be a minimum of three inches, and a maximum of 152 mm (6 inches).
4. Minimum penetration into deck shall be as recommended by the fastener manufacturer. There is a 25 mm (1 inch) minimum for metal, wood and structural concrete decks where not specified by the manufacturer. For gypsum and cement-wood fiber decks, penetration shall be determined from pull-out test results with a minimum penetration of 38 mm (1 ½ inches).

A. Attachment with Insulation Adhesive per ASCE 7-5.

1. Ensure all surfaces are clean, dry, free of dirt, debris, oils, loose ore embedded gravel, unadhered coatings, deteriorated membrane and other contaminants that may inhibit adhesion.
2. Apply insulation adhesive directly to the substrate using a ribbon pattern with 13 mm (½ inch) wide beads, using either the pail or an automatic applicator, at a rate of one (1) gallon per one hundred (150) square feet.
3. Immediately place insulation boards into wet adhesive. Do not slide boards into place. Do not allow the adhesive to skin over before installing insulation boards.
4. Briefly step each board into place to ensure contact with the adhesive. Substrates with irregular surfaces may prevent the insulation board from making positive contact with the adhesive. Relief cuts or temporary weights may be required to ensure proper contact.
5. All boards shall be cut and fitted where the roof deck intersects a vertical surface. The boards shall be cut to fit a minimum of 6 mm (¼ inch) away from the vertical surface.

3.4 CLEANING

A. Remove debris and cartons from roof deck. Leave insulation clean and dry, ready to receive roofing membrane.

3.5 CONSTRUCTION WASTE MANAGEMENT

A. Remove and properly dispose of waste products generated during installation. Comply with requirements of authorities having jurisdiction

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SECTION 07 40 00
ROOFING AND SIDING PANELS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies uninsulated metal wall panels as shown on contract documents.

1.2 RELATED WORK:

A. Sustainable Design Requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS

B. Sealant: Section 07 92 00, JOINT SEALANTS

C. Color and texture of finish: Section 09 06 00, SCHEDULE FOR FINISHES

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Provide metal wall panel products of a manufacturer regularly engaged for not less than five (5) years in the fabrication of metal panels of the type and design indicated.

B. Installer: A firm with three (3) years of successful experience with installation of roofing and siding panels of type and scope equivalent to Work of this Section. Submit installer qualifications.

1.5 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Sustainable Design Submittals, as described below:

1. Postconsumer recycled content as specified in PART 2 - PRODUCTS.

C. Samples: Metal panel, 152 mm (6 inch) square, showing finish, each color and texture.

D. Shop Drawings: Wall panels, showing details of construction and installation. Collateral steel framing, thickness and kind of material, closures, flashing, fastenings and related components and accessories. Show interfaces and relationships to work at other trades and continuity with adjacent thermal and weather barriers.

E. Manufacturer's Literature and Data: Wall panels

F. Manufacturer's Certificates: Indicating manufacturer's qualifications specified.

G. Installer qualifications

H. Manufacturer warranty

1.6 QUALITY ASSURANCE:

A. Approval by Contracting Officer Representative (COR) is required of products of proposed manufacturer.

B. Certify manufacturer has five (5) years continuous documented experience in fabrication of metal roofing and siding panels.

C. Source: For each material type required for work of this section, provide primary materials, which are products of one manufacturer. Provide secondary or accessory materials, which are acceptable to manufacturers of primary materials.

D. Installer: A firm with a minimum of three (3) years' experience in type of work required by this section and which is acceptable to manufacturers of primary materials.

1.7 WARRANTY:

A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".

B. Manufacturer Warranty: Manufacturer shall warranty their metal wall panels for a minimum of ten (10) years from the date of installation and final acceptance by the Government. Submit manufacturer warranty.

C. Warranty on Panel Finishes: Manufacturer's shall warrant their wall panel finish and provide standard agreement to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    b. Chalking in excess of a No. 8 rating when testing according to ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: Ten (10) years from date of installation and final acceptance by the COR.

1.8 APPLICABLE PUBLICATIONS:

A. The publications listed below form a part of this specification to the extend referenced. The publications are referenced in the text by the basic designation only.

B. American Architecture Manufacturers Association (AAMA):

621-02 .... Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates

C. American Iron and Steel Institute (AISI):

SG03-02 .... Cold-Formed Steel Design Manual

D. ASTM International (ASTM):

A463/A463M-10......................... Steel Sheet, Cold-Rolled, Aluminum-Coated, by the Hot-Dip Process

A653/A653M-13......................... Steel Sheet, Zinc-Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

A924/A924M-14......................... Steel Sheet, Metallic Coated by the Hot-Dip Process

A1008/A1008M-10..................... Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy

D2244-14 .... Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D4214-07 .... Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

E1592-10 .... Terminology Relating to Occupational Health and Safety

G. Underwriters Laboratories (UL):

580-05(R2013) .... Tests for Uplift Resistance of Roof Assemblies

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS FOR WALL PANELS:

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592.
   1. Wind Loads: 115 MPH, Exposure ‘C’
   2. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joints sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 67 degrees C (120 degrees F), ambient; 100 degrees C (180 degrees F), material surfaces.

2.2 SHEET STEEL:

A. Minimum 0.8 mm (0.31 inch) thick for wall and roof panels.

B. Steel, Sheet, Galvanized: ASTM A653/A653M and AISI SG03-3, Structural
   1. Grade 40, galvanized coating conforming to ASTM A924/A924M, Class Z 275 G-90.

C. Steel, Sheet, Commercial: ASTM A1008, Type C

D. Steel, Sheet, Aluminized: ASTM A463/A463M and AISI SG03-3. Steel to be coated on both sides with 0.15 Kg/sq. m (0.5 ounce of aluminum per square foot).

E. Recycled Content of Steel Products: Postconsumer recycled content not less than 30 percent.

2.3 FASTENERS:

A. Fasteners for Steel Panels: Galvanized or cadmium plated steel.

C. Fasteners of size, type and holding strength as recommended by panel manufacturer.

2.4 FABRICATION:

A. General:
   1. Furnish panels in continuous length for full horizontal span between corner posts. Run panels with corrugations horizontally, overlapping the corner posts as indicated in drawings. Allow for cut-outs or openings as required for the passage of pipes, conduits, vents, and the like.
   2. Overall thickness of panels is shown of the contract documents.

3. Lap horizontal joints by at least one corrugation and provide continuous bead of sealant. Refer to Section 07 92 00, JOINT SEALANTS for sealing compounds.
5. Provide collateral steel framing, metal and bituminous closures, fastenings, flashing, clip, caulking, panel reinforcements for support of mechanical and electrical work as shown on the contract documents, and related components and accessories.
   a. Sub-girts: 1.0 mm (0.0396 inches) thick galvanized steel hat channels designed to receive panel fasteners or clips.
   b. Accessories, fastenings, and flashings to be the same material and finish as the panels. Thickness and installation of accessories and flashing to be as recommended by the panel manufacturer.

B. Uninsulated Metal Panels:
   1. Panels:
      a. 1.3 mm (0.0516 inch) thick galvanized steel.
      b. 1.25 mm (0.050 inch) thick aluminized steel.

C. Fabricate frames used in conjunction with walls panels to be of same material, thickness and finish as exterior face sheets of wall system.

2.5 FINISH:

A. For uninsulated wall panels provide finishes as follows for face sheets. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. Provide finishes for steel face sheets as follows. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish coating not less than 70 percent PVDF resin by weight in both color coat and clear topcoat; or
2. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat; or
3. FEVE Fluoropolymer: AAMA 2605. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install panels in accordance with the manufacturer's approved erection instructions and diagrams, except as specified otherwise.

B. Install panels in full and firm contact with supports and with each other at side and end laps.

C. Where panels are cut in the field, or where factory applied coverings or coatings are abraded or damaged in handling or installation, make finish repairs with material of the same type and color as the weather coating, before being installed.

D. Seal cut ends and edges, including those at openings through the sheets.

E. Correct defects or errors in the materials in a manner approved by the COR.

F. Replace defective materials which cannot be corrected with nondefective material.

G. Provide molded closure strips where indicated and whenever sheets terminate with open ends after installation.

H. Wall Panels:

1. Apply panels with the configuration in a vertical position.
2. Provide panels in the longest obtainable lengths, with end laps occurring only at structural members. Lap corners.
3. Seal top laps with joint sealing material.
4. Flash and seal walls at the base, at the top, around windows, door frames, framed louvers, and other similar openings. Install closure strips, flashings, and sealing material in an approved manner. Assure that there shall be no retained water

J. Flashing:

1. Provide flashing and related closures and accessories in connection with the preformed metal panels as indicated and as necessary to assure that water will drain from panels without accumulation..
2. Install details of installation, which are not indicated, in accordance with the panel manufacturer's printed instruction and details, or the approved shop drawings.
3. Allow for expansion and contraction of flashing.

K. Fasteners:

1. Space fasteners in accordance with the manufacturer's recommendations, and as necessary to withstand the design loads indicated.
2. Install fasteners in valleys or crowns as recommended by the manufacturer of the panel being used.
3. Install fasteners in straight lines within a tolerance of 13 mm (1/2-inch) in the length of a bay.
4. Drive exposed penetrating type fasteners normal to the surface, and to a uniform depth to seat gasketed washers properly, and drive so as not to damage factory applied coating.
5. Exercise care in drilling pilot holes for fastenings to keep drills perpendicular and centered in valleys, or crowns, as applicable. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Do not torque fasteners to exceed values recommended by the manufacturer.
6. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.
7. Remove metal shavings and filings from roofs on completion to prevent rusting and discoloration of the panels.

3.2 ISOLATION OF ALUMINUM:

A. Isolate aluminum in contact with or fastened to dissimilar metals other than stainless steel, white bronze, or other metal compatible with aluminum by one of the following:

1. Painting the dissimilar metal with a prime coat of Zinc-Molybdate followed by two coats of aluminum paint.
2. Placing a non-abrasive tape or gasket between the aluminum and the dissimilar metal.

B. Paint aluminum in contact with, or built into mortar, concrete, plaster, or other masonry materials with a coat of alkali-resistant bituminous paint.

C. Paint aluminum in contact with wood or other absorptive materials that may become repeatedly wet, with two coats of bituminous paint, or two coats of aluminum paint. Seal joints with caulking material.

3.3 PROTECTION AND CLEANING:

A. Protect panels and other components from damage during and after erection, and until project is accepted by the COR.

B. After completion of work, all exposed finished surfaces of panels are to be cleaned of soil, discoloration and disfiguration. Touch-up abraded surfaces of panels.

- - - E N D - - -

SECTION 07 52 00
MODIFIED BITUMINOUS MEMBRANE ROOFING – COLD APPLIED
PERMANENT ROOF

PART 1 — GENERAL

1.1 SUMMARY

A. Section includes modified bituminous roofing system.

1. Scope of Work

a. Remove existing roof system down to the steel deck.

b. Install Polyiso and ½” asphalt saturated fiber board per ASCE 7-5 to achieve an R value of 30.

c. Install in Green Lock zero VOC adhesive Stressbase 80, 20% pre consumer recycled content, and LEED 10% MR 4 recycled content UL Environment Certified.

d. Install Green Lock zero VOC adhesive base flashings with StressPly E, Bio Based, and recycled content post consumer 11% and 28% pre consumer, LEED 25%, MR 4 recycled content, MR 6 Rapidly renewable content UL Environment Certified.

e. Install in Green Lock zero VOC adhesive StressPly plus FR Mineral Cap sheet, recycled content 6 percent; LEED MR 4 recycled content UL Environment Certified.

f. Install jacks on all penetrations; install new internal drains, repair existing expansion joint per manufactures maintenance guide lines. Install new surface mounted counter flashing.

g. Install All Knight primer and White Star Polyurea in 3/8” white washed gravel, SRI 112, LEED MR 5 Regional Resource, LEED SS 7.2 Heat Island Effect, LEED EA1 Optimize Energy performance.

h. Install roof system per ASCE 7-5, calculations must be building and geographic specific.

i. ASCE 7-5 Calculations and ANSI/SPRI ES1 must be submitted by contractor.

j. Contractor to supply with 5 year material and labor warranty. Manufacturer to supply 30 Year No Dollar limit leak Warranty for entire roof system.

B. Related Sections: N/A

C. Related Work Specified Elsewhere:

1. Metal Roof Decks: Section 05 31 00, STEEL DECKING

2. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION

1.3 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. ASCE 7-05, Minimum Design Loads for Buildings and Other Structures.

B. American Society for Testing and Materials (ASTM):
   1. ASTM D41 Standard Specification for Asphalt Primer Used in Roofing, Damp proofing and Waterproofing.
   2. ASTM D312 Standard Specification for Asphalt Used in Roofing.
   3. ASTM D451 Standard Test Method for Sieve Analysis of Granular Mineral Surfacing for Asphalt Roofing Products.
   4. ASTM D1079 Standard Terminology Relating to Roofing, Waterproofing and Bituminous Materials.
   5. ASTM D1227 Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
   6. ASTM D1863 Standard Specification for Mineral Aggregate Used as a Protective Coating for Roofing.
   7. ASTM D2178 Standard Specification for Asphalt Glass Felt Used as a Protective Coating for Roofing.
   8. ASTM D2822 Standard Specification for Asphalt Roof Cement.
   9. ASTM D2824 Standard Specification for Aluminum-Pigmented Asphalt Roof Coating.
   10. ASTM D4601 Standard Specification for Asphalt Coated Glass Fiber Base Sheet Used in Roofing.
   11. ASTM D5147 Standard Test Method for Sampling and Testing Modified Bituminous Sheet Materials.
   12. ASTM D6162 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements.
   13. ASTM D6163 Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements.
   14. ASTM E108 Standard Test Methods for Fire Test of Roof Coverings.

C. Factory Mutual Research (FM):
   1. Roof Assembly Classifications.

D. National Roofing Contractors Association (NRCA):
   1. Roofing and Waterproofing Manual.

E. Underwriters Laboratories, Inc. (UL):
   1. Fire Hazard Classifications.
   2. Green Certification

F. Warnock Hersey (WH):

1. Fire Hazard Classifications.

G. American National Standards Institute and Single Ply Roofing Institute (ANSI/SPRI)

1. ANSI/SPRI ES-1 Testing and Certification Listing of Shop Fabricated Edge Metal

H. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

1.4 SUBMITTALS FOR REVIEW

A. Product Data: Provide manufacturer's technical product data for each type of roofing product specified. Include data substantiating that materials comply with specified requirements.

B. Samples: Submit two (2) samples of the following:

1. 1 lb. sample of roofing aggregate for review.

C. Specimen Warranty: Provide an unexecuted copy of the warranty specified for this Project, identifying the terms and conditions required of the Manufacturer and the Owner.

D. Any material submitted as equal to the specified material must be accompanied by a report signed and sealed by a professional engineer licensed in the state in which the installation is to take place. This report shall show that the submitted equal meets the Design and Performance criteria in this specification. Substitution requests submitted without licensed engineer approval will be rejected for non-conformance.

1.5 SUBMITTALS FOR INFORMATION

A. Manufacturer's Installation Instructions: Submit installation instructions and recommendations indicating special precautions required for installing the membrane.

B. Manufacturer's Certificate: Certify that roof system furnished is approved by Factory Mutual, Underwriters Laboratories, Warnock Hersey or approved third party testing facility in accordance with ASTM E108, Class A for external fire and meets local or nationally recognized building codes.

C. Manufacturer's Certificate: Certify that the roof system is adhered properly to meet or exceed the requirements of FM 1-90.

D. Manufacturer's Certificate: Certify that the roof system furnished is approved or accepted by Factory Mutual Approval Standard 4470.

E. Manufacturer's Certificate: Certify that materials are manufactured in the United States and conform to requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roof system specified herein.

F. Manufacturer's Certificate: Submit a certified copy of the roofing manufacturer's ISO 9001 compliance certificate.

G. Test Reports: Submit test reports, prepared by an independent testing agency, for all modified bituminous sheet roofing, indicating compliance with ASTM D5147.

H. Written certification from the roofing system manufacturer certifying the applicator is currently authorized for the installation of the specified roof system.

I. Design Loads: Submit copy of manufacturer's minimum design load calculations according to ASCE 7-05, Method 2 for Components and Cladding, sealed by a registered professional engineer. In no case shall the design loads be taken to be less than those detailed in Design and Performance Criteria article of this specification.

J. Qualification data for firms and individuals identified in Quality Assurance Article below.

K. Test Reports: Submit third party validation of environmental claims, prepared UL Environment, and for all modified bituminous sheet material containing recycled content and/or bio based content.

1.6 CONTRACT CLOSEOUT SUBMITTALS

A. General: Comply with Requirements of Division 01 Section - Closeout Submittals.

B. Special Project Warranty: Provide specified warranty for the Project, executed by the authorized agent of the Manufacturer.

C. Roofing Maintenance Instructions. Provide a manual of manufacturer's recommendations for maintenance of installed roofing systems.

D. Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance on roofing and associated work.

E. Demonstration and Training Schedule: Provide a schedule of proposed dates and times for instruction of Owner's personnel in the maintenance requirements for completed roofing work. Refer to Part 3 for additional requirements.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with not less than 12 years documented experience and have ISO 9001 certification.

B. Installer Qualifications: Company specializing in modified bituminous roofing installation with not less than 5 years experience and authorized by roofing system manufacturer as qualified to install manufacturer's roofing materials.

C. Installer's Field Supervision: Maintain a full-time Supervisor/Foreman on job site during all phases of roofing work while roofing work is in progress. Maintain proper supervision of workmen.

D. Maintain a copy of the Contract Documents in the possession of the Supervisor/Foreman and on the roof at all times.

E. Source Limitations: Obtain all components of roof system from a single manufacturer. Secondary products that are required shall be recommended and approved in writing by the roofing system Manufacturer.

1. Upon request of the Architect or Owner, submit Manufacturer's written approval of secondary components in list form, signed by an authorized agent of the Manufacturer.

F. Source Quality Control: Manufacturer shall have in place a documented, standardized quality control program such as ISO-9001.

1.8 PRE-INSTALLATION CONFERENCE

A. Pre-Installation Roofing Conference: Convene a pre-roofing conference approximately two (2) weeks before scheduled commencement of modified bituminous roofing system installation and associated work.

B. Require attendance of installer of each component of associated work, installers of deck or substrate construction to receive roofing work, installers of rooftop units and other work in and around roofing that must precede or follow roofing work (including mechanical work if any), Architect, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of the Work, including (where applicable) Owner's insurers, testing agencies and governing authorities. Objectives of conference include:

1. Review foreseeable methods and procedures related to roofing work, including set up and mobilization areas for stored material and work area.
2. Tour representative areas of roofing substrates (decks) inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by others.
3. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment.
4. Review roofing system requirements (drawings, specifications and other contract documents).
5. Review required submittals both completed and yet to be completed.
6. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
7. Review required inspection, testing, certifying and material usage accounting procedures.

8. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary roofing (if not mandatory requirement).
9. Record discussion of conference including decisions and agreements (or disagreements) reached and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.
10. Review notification procedures for weather or non-working days.

C. The Owner's Representative will designate one of the conference participants to record the proceedings and promptly distribute them to the participants for record.

D. The intent of the conference is to resolve issues affecting the installation and performance of roofing work. Do not proceed with roofing work until such issues are resolved the satisfaction of to the Owner and Architect or Engineer of Record. This shall not be construed as interference with the progress of Work on the part of the Owner or Architect or Engineer of Record.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site with seals and labels intact, in manufacturer's original containers, dry and undamaged.

B. Store and handle roofing sheets in a dry, well-ventilated, weather-tight place to prevent moisture exposure. Store rolls of felt and other sheet materials on pallets or other raised surface. Stand all roll materials on end. Cover rolled goods with a canvas tarpaulin or other breathable material (not polyethylene).

C. Do not leave unused materials on the roof overnight or when roofing work is not in progress unless protected from weather and other moisture sources.

D. Secure all material and equipment on the job site. If any material or equipment is stored on the roof, assure that the integrity of the deck is not compromised at any time. Damage to the deck caused by the Contractor's actions will be the sole responsibility of the Contractor, and the deck will be repaired or replaced at his expense.

1.10 MANUFACTURER'S INSPECTIONS

A. When the Project is in progress, the roofing system manufacturer will provide the following:
1. Report progress and quality of the work as observed.
2. Provide daily job site inspections.
3. Report to the Architect and Owner in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.

4. Confirm after completion that manufacturer has observed no application procedures in conflict with the specifications other than those that may have been previously reported and corrected.

1.11 PROJECT CONDITIONS

A. Proceed with roofing work only when existing and forecasted weather conditions will permit a unit of work to be installed in accordance with manufacturer's recommendations and warranty requirements.

B. Do not apply roofing insulation or membrane to damp deck surface.

C. Do not expose materials subject to water or solar damage in quantities greater than can be weatherproofed during same day.

D. All slopes greater than 2:12 require back-nailing to prevent slippage of the ply sheets. Use ring or spiral-shank one (1) inch cap nails, or screws and plates at a rate of one (1) fastener per ply (including the membrane) at each insulation stop. Place insulation stops at 16 ft o.c. for slopes less than 3:12 and four (4) ft o.c. for slopes greater than 3:12. On non-insulated systems, nail each ply directly into the deck at the rate specified above. When slope exceeds 2:12, install all plies parallel to the slope (strapping) to facilitate back nailing. Install four (4) additional fasteners at the upper edge of the membrane when strapping the plies.

1.12 SEQUENCING AND SCHEDULING

A. Sequence installation of roofing with related units of work specified in other Sections to ensure that roof assemblies, including roof accessories, flashing, trim and joint sealers, are protected against damage from effects of weather, corrosion and adjacent construction activity.

B. Complete all roofing field assembly work each day. Phased construction will not be accepted.

1.13 WARRANTY

A. Upon completion of installation, and acceptance by the Owner and Architect, the Manufacturer will supply to the Owner a 30 year No Dollar Limit leak warranty.

B. Installer will submit a 5 year warranty to the membrane manufacturer with a copy directly to Owner.

1.14 DESIGN AND PERFORMANCE CRITERIA

A. Uniform Wind Uplift Load Capacity

1. Installed roof system shall withstand negative (uplift) design wind loading pressures complying with ASCE 7-5.

a. Design Code: ASCE 7-05, Method 2 for Components and Cladding.

B. Live Load: 20 psf, or not to exceed original building design.

C. Dead Load: Loading of the roof structure, due to tear off of existing, and/or installation of new roofing materials shall not exceed the present loading due to weight of the existing roofing system.

PART 2 — PRODUCTS

2.1 PRODUCTS, GENERAL

A Basis of Design: Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

B. Substitutions: Products proposed as equal to the products specified in this Section shall be submitted in accordance with Bidding Requirements and Division 01 provisions.

1. Proposals shall be accompanied by a copy of the manufacturer's standard specification section. That specification section shall be signed and sealed by a professional engineer licensed in the state in which the installation is to take place. Substitution requests containing specifications without licensed engineer certification shall be rejected for non-conformance.
2. Include a list of three (3) projects of similar type and extent, located within a one hundred mile radius from the location of the project. In addition, the three projects must be at least five (5) years old and be available for inspection by the Architect, Owner or Owner's Representative.
3. Equivalency of performance criteria, warranty terms, submittal procedures, and contractual terms will constitute the basis of acceptance.
4. The Owner's decision regarding substitutions will be considered final. Unauthorized substitutions will be rejected.

2.2 ACCEPTABLE MANUFACTURERS

A. The design is based upon roofing systems engineered and manufactured by The Garland Company:

The Garland Company
3800 East 91st Street
Cleveland, Ohio 44105
Sean Magee
Telephone: 310 420 0713
Email: smagee@garlandind.com

2.3 DESCRIPTION

A. Modified bituminous sheet roofing work including but not limited to:

1. One ply of Garland StressBase Plus 80 base sheet bonded to the prepared substrate with Green Lock adhesive.
2. Cold Applied Polyether Green Lock: V.O.C. free, non-asbestos containing cold applied adhesive for roof slopes up to 3:12.
3. Base Flashing Ply: One (1) ply of STRESSPLY E; 80 mil SBS and SIS base flashing ply covered by an additional layer of modified bitumen membrane and set in bitumen.
4. Modified Membrane: STRESSPLY PLUS FR MINERAL - Environmentally Friendly; 145 mil SBS (Styrene-Butylene-Styrene) mineral surfaced, rubber modified roofing membrane incorporating recycled rubber, fire retardant characteristics and reinforced with a fiberglass and polyester composite scrim.
5. Surfacing: ASTM D1863 roofing aggregate consisting of slag, pea gravel or white spar. The aggregate will be set into a cold applied White Star Polyurea cool roof coat.

2.4 BITUMINOUS MATERIALS

A. Asphalt Primer: V.O.C. compliant, ASTM D41.

B. Flashing Adhesive Green Lock: V.O.C. free, ASTM D2822, Type II.

C. Cold Applied Solvent Free Flood Coat: Green-Lock Membrane Adhesive; Zero VOC, polyether, cold process flood coat having the following characteristics:
   1. Non-Volatile Content ASTM D4586 100%
   2. Density ASTM D1475 11.2 lbs./gal. (1.11 g/m3)
   3. Viscosity Stormer ASTM D562 16-20 sec.
   4. Flash Point ASTM D93 400 F min. (232 C)
   5. Slope: up to 3:12
   6. Roofing Aggregate: To conform to ASTM D1863
      a. White Spar

D. Cold Applied Flood Coat Adhesive Performance Requirements:
   1. Non-Volatile Content ASTM D4479 75%
   2. Density ASTM D1475 9.1 lbs./gal. (1kg/l)
   3. Viscosity Stormer ASTM D4449 20-25 sec.
   4. Flash Point ASTM D93 100°F (37°C)

E. Brush Grade Green Lock Flashing Adhesive
   1. Performance Requirements:
   2. Non-Volatile Content ASTM D4479 70 min.
   3. Density ASTM D1475 8.6 lbs./gal. (1kg/l)

4. Flash Point ASTM D93 100°F (37°C)

2.5 SHEET MATERIALS

A. Base Ply (StressBase 80 Sheet): Fiberglass scrim with the following minimum performance requirements according to ASTM D5147. Properties (Finished Membrane):

1. Tensile Strength (ASTM D2523)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 100 lbf/in CMD 100 lbf/in
    b. 50mm/min. @ 23 ± 3°C MD 39 kN/m CMD 39 kN/m
2. Tear Strength (ASTM D4073)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 110 lbf CMD 110 lbf
    b. 50mm/min. @ 23 ± 3°C MD 1335 N CMD 1335 N
3. Elongation at Maximum Tensile (ASTM D2523)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 2.5 % CMD 2.5 %
    b. 50mm/min@ 23 ± 3°C MD 2.5 % CMD 2.5 %

B. Base Flashing Ply: Modified Membrane Properties (Finished Membranes): STRESSPLY "E"; ASTM D6162, Type III Grade S

1. Tensile Strength (ASTM D5147)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 500 lbf/in CMD 550 lbf/in
    b. 50 mm/min. @ 23 ± 3°C MD 87.5 kN/m CMD96.2 kN/m
2. Tear Strength (ASTM D5147)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 900 lbf CMD 950 lbf
    b. 50 mm/min. @ 23 ± 3°C MD 4003 N CMD 4226 N
3. Elongation at Maximum Tensile (ASTM D5147)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 6.0% CMD 6.0%
    b. 50 mm/min. @ 23 ± 3°C MD 6.0% CMD 6.0%
4. Low Temperature Flexibility (ASTM D5147): Passes -30°F (-34°C)

C. Modified Flashing Ply

1. STRESSPLY PLUS FR MINERAL

D. Modified Membrane Properties (Finished Membranes): STRESSPLY PLUS FR MINERAL; ASTM D6162, Type III Grade G

1. Tensile Strength (ASTM D5147)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 310 lbf/in CMD 310 lbf/in
    b. 50 mm/min. @ 23 ± 3°C MD 54.2 kN/m CMD 54.2 kN/m
2. Tear Strength (ASTM D5147)
    a. 2 in/min. @ 73.4 ± 3.6°F MD 500 lbf CMD 500 lbf
    b. 50 mm/min. @ 23 ± 3°C MD 2224 N CMD 2224 N
3. Elongation at Maximum Tensile (ASTM D5147)

a. 2 in/min. @ 73.4 ± 3.6°F MD 3.5% CMD 3.5%

b. 50 mm/min. @ 23 ± 3°C MD 3.5% CMD 3.5%

2.6 SURFACINGS

A. Polyurea Flood Coat Adhesive: White Star; one-component, flexible, low odor, polyurea roof adhesive top coat. Performance Requirements:

1. Non-Volatile Content ASTM D2369 89%
2. Density 9.85 lbs./gal.
3. V.O.C. Less than 130 g/L, SRI 112
4. Viscosity at 77 ºF Brookfield viscometer 60 poise
5. Flash Point ASTM D93 120ºF (41°C)
6. Roofing Aggregate: To conform to ASTM D1863
   a. White Spar

2.7 RELATED MATERIALS

A. Roof Insulation: In accordance with Section 07 22 00.

B. Roof Insulation Fasteners: In accordance with Section 07 22 00.

D. Nails and Fasteners: Non-ferrous metal or galvanized steel, except that hard copper nails shall be used with copper; aluminum or stainless steel nails shall be used with aluminum; and stainless steel nails shall be used with stainless steel, I addition plates should be used. Fasteners shall be self-clinching type of penetrating type as recommended by the manufacturer of the deck material. Nails and fasteners shall be flush-driven through flat metal discs of not less than one (1) inch diameter. Omit metal discs when one-piece composite nails or fasteners with heads not less than one (1) inch diameter are used.

E. Metal Discs: Flat discs or caps of zinc-coated sheet metal not lighter than twenty eight (28) gauge and not less than one (1) inch in diameter. Form discs to prevent dishing. Bell or cup shaped caps are not acceptable.- termination bar should be extruded aluminum .125 x 1"

F. Urethane Sealant: One part, non-sag sealant as approved and furnished by the membrane manufacturer for moving joints.

1. Tensile Strength (ASTM D412): 250 psi
2. Elongation (ASM D412): 950%
3. Hardness, Shore A (ASTM C920): 35
4. Adhesion-in-Peel (ASTM C920): 30 pli

G. Sealant: Single component, 100% solids structural adhesive as furnished and recommended by the membrane manufacturer.

1. Elongation (ASTM D412) 300%
2. Hardness, Shore A (ASTM C920) 50

3. Shear Strength (ASTM D1002) 300 psi

H. Butyl Tape: 100% solids, asbestos free and compressive tape designed to seal as recommended and furnished by the membrane manufacturer.

I. Glass Fiber Cant: Continuous triangular cross Section made of inorganic fibrous glass used as a cant strip as recommended and furnished by the membrane manufacturer.

J. Roof Drains: Drain system as recommended and furnished by the membrane manufacturer.

K. Drain Flashings should be 4lb (1.8kg) sheet lead formed and rolled

L. Plumbing stacks should be 4lb (1.8kg) sheet lead formed and rolled.

M. Counter flashing, scuppers, and other sheet metal: ASTM A653 Standard specification for sheet metal, Zinc coated (galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process Zinc –coated steel, in thickness of 24 gauge.

PART 3 — EXECUTION

3.1 EXECUTION, GENERAL

A. Comply with requirements of Division 01 Section "Common Execution Requirements."

3.2 EXAMINATION

A. Verify that deck surfaces and project conditions are ready to receive work of this section.

B. Verify that deck is supported and secured to structural members.

C. Verify that deck is clean and smooth, free of depressions, projections or ripples, and is properly sloped to drains.

D. Verify that adjacent roof substrate components do not vary more than [1/4] inch in height.

E. Verify that deck surfaces are dry.

F. Confirm that moisture content does not exceed twelve (12) percent by moisture meter tests. On concrete deck pour hot asphalt on to deck if it bubbles / foams and once cooled does not adhere to the substrate, the moisture levels are too high.

G. Verify that openings, curbs, pipes, conduit, sleeves, ducts, and other items which penetrate the roof are set solidly, and that wood cant strips, wood nailing strips, and reglets are set in place.

3.3 DECK PREPARATION

A. Metal Deck

1. Verify that all welds are good, that deck is in plane and that it is free from damage and deflection.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Cooperate with manufacturer, inspection and test agencies engaged or required to perform services in connection with installing the roof system.

B. Insurance/Code Compliance: Where required by code, install and test the roofing system to comply with governing regulation and specified insurance requirements.

C. Protect other work from spillage of roofing materials and prevent materials from entering or clogging drains and conductors. Replace or restore other work damaged by installation of the coal tar modified bituminous roofing system.

D. Coordinate installation of roofing system components so that insulation and roofing plies are not exposed to precipitation or left exposed overnight. Provide cut-offs at end of each day's work to cover exposed ply sheets and insulation with two (2) plies of an SBS modified base sheets set in cold applied mastic with joints and edges sealed with roofing cement. Remove cut-offs immediately before resuming work.

E. Substrate Joint Penetrations: Prevent bitumen from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

F. Apply roofing materials as specified by manufacturer's instructions.

1. Keep roofing materials dry before and during application.
2. Do not permit phased construction.
3. Complete application of roofing plies, modified sheet and flashing in a continuous operation.
4. Begin and apply only as much roofing in one day as can be completed that same day.
5. Cut-Offs (Waterstops): At end of each day's roofing installation, protect exposed edge of incomplete work, including ply sheets and insulation. Provide temporary covering of two (2) plies of #15 organic roofing felt set in roofing cement with joints and edges sealed.

3.5 VAPOR RETARDER INSTALLATION: N/A

3.6 INSULATION INSTALLATION

A. Deck type: Metal

B. Insulation: Polyiso and ½" asphalt saturated fiber board to achieve R-value of 30.

C. Insulation attachment: Per ASCE 7-5 building and site specific.

3.7 BASE PLY INSTALLATION

A. Ply: Install (1) one ply of Stressbase 80 base sheet in (2) to two and one half (2 ½) gallons per ply per square of Green Lock adhesive shingled uniformly throughout over the prepared substrate. Shingle in proper direction to shed water on each large area of roofing. Prior to installation, cut sheets into 18' lengths and allow relaxing.

B. Lap ply sheet ends eight inches. Stagger end laps twelve inches minimum.

C. Extend plies two inches beyond top edges of cants at wall and projection bases.

D. Install base flashing ply to all perimeter and projection details.

E. Allow the one ply of base sheet to cure at least thirty minutes before installing the modified membrane. However, the modified membrane must be installed the same day as the base plies.

3.8 MODIFIED MEMBRANE APPLICATION

A. Solidly bonded to the base layers with specified cold adhesive at the rate of (2) two and one half (2 ½) gallons per 100 square feet.

B. The roll must push a puddle of adhesive in front of it with adhesive slightly visible at all side laps. Care should be taken to eliminate air entrapment under the membrane.

C. Subsequent rolls of modified shall be installed across the roof as above with a minimum of four (4) side laps and eight (8) end laps. The end laps shall be staggered. The modified membrane shall be laid in the same direction as the under layers but the laps shall not coincide with the laps of the base layers.

D. For best results, allow the cold adhesive to set for five (5) to ten (10) minutes before installing the top layer of modified membrane.

E. Extend membrane two (2) beyond top edge of all cants in full moppings of the cold adhesive as shown on the drawings.

3.9 FLASHING MEMBRANE INSTALLATION

A. Seal all curb, wall and parapet flashings with an application of mastic and mesh on a daily basis. Do not permit conditions to exist that will allow moisture to enter behind, around or under the roof or flashing membrane.

B. Prepare all walls, penetrations, expansion joints and where shown on the drawings to be flashed with asphalt primer at the rate of one hundred (100) square feet per gallon. Allow primer to dry tack free.

C. Use the modified membrane as the flashing membrane. Adhere to the underlying base flashing ply with specified asphalt unless otherwise noted in these specifications. Nail off at a minimum of eight (8) inches (203mm) o.c. from the finished roof at all vertical surfaces.

D. Solidly adhere the entire sheet of flashing membrane to the substrate. Tops of all flashings that are not run up and over curb shall be secured through termination bar 6 inches (152mm) and sealed at top.

E. Seal all vertical laps of flashing membrane with a three-course application of trowel-grade mastic and fiberglass mesh.

F. Coordinate counter flashing, cap flashings, expansion joints and similar work with modified bitumen roofing work [as specified in other sections].

G. Coordinate roof accessories, miscellaneous sheet metal accessory items, including piping vents and other devices with the roofing system work [as specified in other sections]. When using mineralized cap sheet all stripping shall be installed prior to cap sheet installation.

3.10 FLASHING MEMBRANE INSTALLATION

A. Surface Mounted Counterflashing:

1. Minimum flashing height is eight (8) inches (203mm) above finished roof height. Maximum flashing height is 24 inches. Prime vertical wall at a rate of 100 square feet per gallon and allow drying.
2. Set cant in bitumen. Run all field plies over cant a minimum of two (2) inches (50mm).
3. Install base flashing ply covering wall set in solvent free flashing adhesive with six (6) inches (152mm) on to field of the roof.
4. Install a second ply of modified flashing ply in solvent free flashing adhesive over the base flashing ply, nine (9) inches (228mm) on to the field of the roof. Apply a three-course application of solvent free flashing adhesive and mesh at all vertical seams and allow curing and aluminizing.
5. Apply butyl tape to wall behind flashing. Secure termination bar through flashing, butyl tape and into wall. Alternatively use caulk to replace the butyl tape.
6. Secure counterflashing set on butyl tape above flashing at eight (8) inches (203mm) o.c. and caulk top of counterflashing.

B. Curb Detail/Air Handling Station:

1. Minimum curb height is eight (8) inches (203mm) above finished roof height. Prime vertical at a rate of 100 square feet per gallon and allow to dry.
2. Set cant in bitumen. Run all field plies over cant a minimum of two (2) inches (50mm).
3. Install base flashing ply covering curb set in bitumen with six (6) inches (152mm) on to field of the roof.
4. Install a second ply of modified flashing ply in bitumen over the base flashing ply, nine (9) inches (228mm) on to the field of the roof. Apply a three-course application of mastic and mesh at all vertical seams and allow to cure and aluminize.
5. Install pre-manufactured counterflashing with fasteners and neoprene washers or per manufacturer's recommendations.
6. Set equipment on neoprene pad and fasten as required by equipment manufacturer.

C. Exhaust Fan:

1. Minimum curb height is eight (8) inches (203mm) above finished roof height. Prime vertical at a rate of 100 square feet per gallon and allow to dry.
2. Set cant in bitumen. Run all plies over cant a minimum of two (2) inches (50mm).
3. Install base flashing ply covering curb with six (6) inches (152mm) on to field of the roof.
4. Install a second ply of modified flashing ply installed over the base flashing ply, nine (9) inches (228mm) on to field of the roof. Attach top of membrane to top of wood curb and nail at eight (8) inches (203mm) o.c. Apply a three-course application of mastic and mesh at all vertical seams and allow to cure and aluminize.
5. Install metal exhaust fan over the wood nailers and flashing to act as counterflashing. Fasten per manufacturer's recommendation.

F. Roof Drain:

1. Plug drain to prevent debris from entering plumbing.
2. Taper insulation to drain minimum of 24 inches (609mm) from center of drain.
3. Run roof system plies over drain. Cut out plies inside drain bowl.
4. Set lead/copper flashing (30 inch square minimum) in ¼ inch bed of mastic. Run lead/copper into drain a minimum of two (2) inches (50mm). Prime lead/copper at a rate of 100 square feet per gallon and allow to dry.
5. Install base flashing ply (40 inch square minimum) in bitumen.
6. Install modified membrane (48 inch square minimum) in bitumen.
7. Install clamping ring and assure that all plies are under the clamping ring.
8. Remove drain plug and install strainer.

G. Plumbing Stack:

1. Minimum stack height is 12 inches (609mm).
2. Run roof system over the entire surface of the roof. Seal the base of the stack with elastomeric sealant.
3. Prime flange of new sleeve. Install properly sized sleeves set in ¼ inch (6mm) bed of roof cement.
4. Install base flashing ply in bitumen.
5. Install membrane in bitumen.
6. Caulk the intersection of the membrane with elastomeric sealant.
7. Turn sleeve a minimum of one (1) inch (25mm) down inside of stack.

H. Heat Stack:

1. Minimum stack height is 12 inches (609mm).
2. Run roof system over the entire surface of the roof. Seal the base of the stack with elastomeric sealant.

3. Prime flange of new sleeve. Install properly sized sleeves set in ¼ inch (6mm) bed of roof cement.
4. Install base flashing ply in bitumen.
5. Install modified membrane in bitumen.
6. Caulk the intersection of the membrane with elastomeric sealant.
7. Install new collar over cape. Weld collar or install stainless steel draw brand.

3.11 APPLICATION OF SURFACING

A. Prior to installation of surface, obtain approval from manufacturer as to work completed.

B. Aggregate Surfacing

1. Apply surfacing materials in quantities specified (two hundred (200) lbs. (90.5 kg) per square for white spar). Uniformly embed aggregate in a flood coat of cold process polyurea at a rate of two (2) gallons per square coverage after felt flashings, tests, repairs and corrective actions have been completed and approved.
2. Aggregate shall be dry and placed in a manner required to form a compact, embedded overlay. To aid in proper embedment, lightly roll aggregate provided that there is no damage to the roofing membrane.

C. Reflective Coating:

1. Allow all cold applied mastics and coating to properly dry and cure before installing the coating.
2. Apply all exposed membrane with manufacturer's White Star, polyurea based roof coating installed at a rate of 2 gallon per square. Apply one gallon per square and broad cast 2lbs per square foot of white washed gravel into wet coating and then immediately apply another 1 gallon per square foot White Star Polyurea.

D. Mineral Surfaced Membrane System: While bleed out from the side and end laps are still cold, hand broadcast minerals into asphalt bleed out for a monolithic appearance.

3.12 FIELD QUALITY CONTROL

A. Perform field inspection and [and testing] as required [under provisions of Division 01].

B. Correct defects or irregularities discovered during field inspection.

C. Require attendance of roofing [and insulation] materials manufacturers' representatives at site during installation of the roofing system. A copy of the specification should also be on site at all times.

3.13 CLEANING

A. Remove bitumen adhesive drippings from all walls, windows, floors, ladders and finished surfaces.

B. In areas where finished surfaces are soiled by asphalt or any other sources of soiling caused by work of this section, consult manufacturer of surfaces for cleaning instructions and conform to their instructions.

C. Repair or replace defaced or disfigured finishes caused by work of this section.

3.14 CONSTRUCTION WASTE MANAGEMENT

A. Remove and properly dispose of waste products generated during roofing procedures. Comply with requirements of authorities having jurisdiction.

3.15 FINAL INSPECTION

A. At completion of roofing installation and associated work, meet with Contractor, Architect, installer, installer of associated work, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of roofing system.

B. Walk roof surface areas of the building, inspect perimeter building edges as well as flashing of roof penetrations, walls, curbs and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.

C. The roofing system manufacturer reserves the right to request a thermo graphic scan of the roof during final inspection to determine if any damp or wet materials have been installed. The thermo graphic scan shall be provided by the [Roofing] Contractor.

D. If core cuts verify the presence of damp or wet materials, the [Roofing] Contractor shall be required to replace the damaged areas at his own expense.

E. Repair or replace deteriorated or defective work found at time above inspection as required to a produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

F. Notify the Contractor, Architect, Owner upon completion of corrections.

G. Following the final inspection, provide written notice of acceptance of the installation from the roofing system manufacturer.

3.16 DEMONSTRATION AND TRAINING

A. At a time and date agreed to by the Owner, instruct the Owner's facility manager, or other representative designated by the Owner, on the following procedures:

1. Roof troubleshooting procedures.
2. Notification procedures for reporting leaks or other apparent roofing problems.
3. Roofing maintenance.
4. The Owner's obligations for maintaining the roofing warranty in effect and force.
5. The Manufacturer’s obligations for maintaining the roofing warranty in effect and force.

- - - END - - -

SECTION 07 60 00
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Formed sheet metal work for wall and roof flashings, copings, and drainage specialties are specified in this section.

1.2 RELATED WORK

A. Flashing components of factory finished roofing and wall systems: Division 07 roofing and wall system sections

B. Integral flashing components of manufactured roof specialties and accessories or equipment: Section 07 72 00, ROOF ACCESSORIES

C. Sealant compound and installation: Section 07 92 00, JOINT SEALANTS

D. Paint materials and application: Section 09 91 00, PAINTING

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below for 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):

A167-99(R 2004)........................Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

A653/A653M-07 ....Steel Sheet Zinc-Coated (Galvanized) or Zinc Alloy Coated (Galvanized) by the Hot- Dip Process

B32-04..Solder Metal

D173-03 ....Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing

D412-06 ....Vulcanized Rubber and Thermoplastic Elastomers-Tension

D1187-97 (R2002) ....Asphalt Base Emulsions for Use as Protective Coatings for Metal

D4586-07 ....Asphalt Roof Cement, Asbestos Free

C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual (Sixth Edition, 2003)

D. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-505-88........................Metal Finishes Manual

E. Federal Specification (Fed. Spec):

A-A-1925A..................................Shield, Expansion; (Nail Anchors)

UU-B-790A.................................Building Paper, Vegetable Fiber

F. International Code Commission (ICC):

International Building Code, Current Edition

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

B. Shop Drawings:

1. Flashings
2. Copings

C. Manufacturer's Literature and Data:

1. Two-piece counterflashing
2. Nonreinforced, elastomeric sheeting

D. Certificates: Indicating compliance with specified finishing requirements, from applicator and contractor

1.4 PERFORMANCE REQUIREMENTS

A. Wind Uplift Forces: Resist the following forces per FM Approvals 1-49:

1. Wind Zone 2: 1.48 to 2.15 kPa (31 to 45 lbf/sq. ft.): 4.31-kPa (90-lbf/sq. ft.) perimeter uplift force, 5.74-kPa (120-lbf/sq. ft.) corner uplift force, and 2.15-kPa (45-lbf/sq. ft.) outward force.

B. Wind Design Standard: Fabricate and install copings tested per ANSI/SPRI ES-1 to resist design pressure indicated on Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Flashing and Sheet Metal materials shall be free of lead, cadmium, and copper.

B. Solder: ASTM B32; flux type and alloy composition as required for use with metals to be soldered.

C. Stainless Steel: ASTM A167, Type 302B, dead soft temper

D. Galvanized Sheet: ASTM, A653

E. Nonreinforced, Elastomeric Sheeting: Elastomeric substances reduced to thermoplastic state and extruded into continuous homogenous sheet (0.056 inch) thick. Sheeting shall have not less than 7 MPa (1,000 psi) tensile strength and not more than seven percent tension-set at 50 percent elongation when tested in accordance with ASTM D412. Sheeting shall show no cracking or flaking when bent through 180 degrees over a 1 mm (1/32 inch) diameter mandrel and then bent at same point over same size mandrel in opposite direction through 360 degrees at temperature of -30 degrees C (-20 degrees F).

F. Bituminous Paint: ASTM D1187, Type I

G. 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

H. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.

I. Roof Cement: ASTM D4586

2.2 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: 0.32 mm (0.013 inch/30 gauge) thick
2. Galvanized steel: 0.55 mm (0.022 inch/26 gauge) thick

C. Exposed Locations:

1. Stainless steel: 0.40 mm (0.016 inch/28 gauge)

D. Thickness of galvanized steel is specified with each item.

2.3 FABRICATION, GENERAL

A. Jointing:

1. In general, stainless steel, except expansion and contraction joints, shall be locked and soldered.
2. Jointing of stainless steel over 0.48 mm (0.019 inch/26 gauge) 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 (one 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. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
   c. Completely remove acid and flux after soldering is completed.

B. 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 inches) 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 inches) 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.

C. Edge Strips or Continuous Cleats:
1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Except as otherwise specified, fabricate edge strips of minimum 0.64 mm (0.025 inch/24 gauge,) thick stainless steel.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 0.8 mm (0.031 inch/22 gauge) thick stainless steel.

D. Drips:
1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.

E. Edges:
1. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge strip or cleat. Use 6 mm (1/4 inch) minimum penetration beyond wall face with drip for through-wall flashing exposed edge.

F. Metal Options:
1. Where options are permitted for different metals use only one metal throughout.
2. Stainless steel may be used in concealed locations for fasteners of other metals exposed to view.

2.4 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, 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. Finish painted under Section 09 91 00, PAINTING unless specified as prefinished item.
      b. Manufacturer's finish:
         1) Fluorocarbon Finish: AAMA 621, high performance organic coating.

2.5 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 0.48 mm (26 gage, 0.019 inch) stainless steel.
   3. Use stainless steel at pipe flashings.

B. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inches) nor more than 400 mm (16 inches).

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. Flashing at Pipes or Conduits (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 or conduit 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 inches) to 450 mm (18 inches) above roof:
      a. Form top of sleeve to turn down into the pipe or conduit at least 25 mm (one inch).
      b. Allow for loose fit around and into the pipe or conduit.
   4. At high pipes or conduits and pipes or conduits with goosenecks or other obstructions which would prevent turning the flashing down into the pipe or conduit:
      a. Extend sleeve up not less than 300 mm (12 inches) above roofing.
      b. Allow for loose fit around pipe or conduit.

2.6 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 existing work use surface applied type, formed to provide a space for the application of sealant at the top edge.

C. Surface Mounted Counterflashing; one or two piece:
   1. Use at existing or new surfaces where flashing cannot be inserted in vertical surface.
   2. One piece: Fabricate upper edge folded double for 65 mm (2 1/2 inches) with top 19 mm (3/4 inch) bent out to form "V" joint sealant pocket with vertical surface. Perforate flat double area against vertical surface with horizontally slotted fastener holes at 400 mm (16 inches) centers between end holes. Option: One piece surface mounted counter-flashing (cap flashing) may be used. Fabricate as detailed on Plate 51 of SMACNA Architectural Sheet Metal Manual.
   3. Two pieces: Fabricate upper edge to lock into surface mounted receiver. Fabricate receiver joint sealant pocket on upper edge and lower edge to receive counterflashing, with slotted fastener holes at 400 mm (16 inches) centers between upper and lower edge.

D. Pipe or Conduit Counterflashing:
   1. Form flashing for water-tight umbrella with upper portion against pipe or conduit to receive a draw band and upper edge to form a "V" joint sealant receiver approximately 19 mm (3/4 inch) deep.
   2. Fabricate 100 mm (4 inch) over lap at end.
   3. Fabricate draw band of same metal as counter flashing. Use 0.33 mm (0.013 inch/30 gauge) thick stainless steel.
   4. Use stainless steel bolt on draw band tightening assembly.
   5. Vent pipe counter flashing may be fabricated to omit draw band and turn down 25 mm (one inch) inside vent pipe.

2.7 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 black iron or galvanized 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. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inches) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
6. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
7. Nail continuous cleats on 75 mm (3 inches) on centers in two rows in a staggered position.
8. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
9. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.

10. 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.
11. 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.
12. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
13. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.
14. Combustible materials shall not be in contact with engine exhaust pipe collar.

3.2 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 inches) 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 (10 feet). Install a 75 mm (3 inches) 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 inches).

3.3 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 inches).

3. Install upper edge or top of counterflashing not less than 225 mm (9 inches) above top of the roofing.
4. Lap joints not less than 100 mm (4 inches). 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, use screws driven in expansion shields set in concrete. Use screws to wood and sheet metal.

B. One Piece Counterflashing:
1. Where flashing is surface mounted on flat surfaces:
    a. When top edge is double folded anchor flat portion below sealant "V" joint with fasteners spaced not over 400 mm (16 inches) on center:
        1) Use screws to sheet metal or wood.
    b. Fill joint at top with sealant.
2. Where flashing or hood is mounted on pipe or conduit:
    a. Secure with draw band tight against pipe or conduit.
    b. Set hood and secure to pipe with a one by 25 mm x 3 mm (1 x 1/8 inch) bolt on stainless steel draw band type clamp, or a stainless worm gear type clamp.
    c. Completely fill joint at top with sealant.

C. When counter flashing is a component of other flashing install as shown.

3.4 COPINGS

A. General:
1. On walls topped with a wood plank, install a continuous edge strip on the front and rear edge 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.

C. Stainless 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.

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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. Sealants and application: Section 07 92 00, JOINT SEALANTS

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.

C. List of FM, UL, or WH classification number of systems installed.

D. 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, except extend the warranty period to five years.

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):

E84-10 ....Surface Burning Characteristics of Building Materials

E814-11.....................................Fire Tests of Through-Penetration Fire Stops

C. Factory Mutual Engineering and Research Corporation (FM):

Annual Issue Approval Guide Building Materials

D. Underwriters Laboratories, Inc. (UL):

Annual Issue Building Materials Directory

Annual Issue Fire Resistance Directory

1479-10 ....Fire Tests of Through-Penetration Firestops

E. Warnock Hersey (WH):

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^2 (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. Sealant materials shall be free of lead, cadmium, and copper.

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 ASTM E814.

H. Materials to be asbestos free.

2.2 SMOKE STOPPING IN SMOKE PARTITIONS

A. Use silicone sealant in smoke partitions as specified in Section 07 92 00, JOINT SEALANTS.

B. Use mineral fiber filler and bond breaker behind sealant.

C. Sealants shall have a maximum flame spread of 25 and smoke developed of 50 when tested in accordance with E84.

D. When used in exposed areas capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.

PART 3 - EXECUTION

3.1 EXAMINATION

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 (six 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 Project Engineer.

C. Clean up spills of liquid type materials.

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

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. 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 AND STEAM GENERATION.

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 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. VOC: Acrylic latex and Silicon sealants shall have less than 50g/l VOC content.

F. 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.

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 degrees C (40 degrees 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 degrees C (90 degrees F) or less than 5 degrees C (40 degrees 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, except that warranty period shall be extended to two 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):

C509-06 ....Elastomeric Cellular Preformed Gasket and Sealing Material
C612-10 ....Mineral Fiber Block and Board Thermal Insulation
C717-10 ....Standard Terminology of Building Seals and Sealants
C834-10 ....Latex Sealants
C919-08. ....Use of Sealants in Acoustical Applications
C920-10 ....Elastomeric Joint Sealants
C1021-08 ....Laboratories Engaged in Testing of Building Sealants
C1193-09 ....Standard Guide for Use of Joint Sealants
C1330-02 (R2007) ....Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
D1056-07 ....Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
E84-09.......................................Surface Burning Characteristics of Building Materials

C. Sealant, Waterproofing and Restoration Institute (SWRI).
The Professionals' Guide

PART 2 - PRODUCTS

2.1 SEALANTS:

A. S-1:
1. ASTM C920, polyurethane or polysulfide
2. Type M
3. Class 25
4. Grade NS
5. Shore A hardness of 20-40

B. S-2:
1. ASTM C920, polyurethane or polysulfide

2. Type M
3. Class 25
4. Grade P
5. Shore A hardness of 25-40

C. S-3:

1. ASTM C920, polyurethane or polysulfide
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 or polysulfide
2. Type S
3. Class 25
4. Grade NS
5. Shore A hardness of 25-40

E. S-5:

1. ASTM C920, polyurethane or polysulfide
2. Type S.
3. Class 25
4. Grade P
5. Shore hardness of 15-45

F. 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

G. 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

H. S-8:
   1. ASTM C920, silicone, acetoxy cure
   2. Type S
   3. Class 25
   4. Grade NS
   5. Shore A hardness of 25-30
   6. Structural glazing application

I. 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

J. S-10:
   1. ASTMC C920, coal tar extended fuel resistance polyurethane
   2. Type M/S
   3. Class 25
   4. Grade P/NS
   5. Shore A hardness of 15-20

K. 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

L. 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

2.2 CAULKING COMPOUND:

A. C-1: ASTM C834, acrylic latex

B. C-2: One component acoustical caulking, non drying, non hardening, synthetic rubber

2.3 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.

2.4 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. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32° C (minus 26° F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

D. 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.

2.5 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

2.6 PRIMER:

A. As recommended by manufacturer of caulking or sealant material.

B. Stain free type

2.7 CLEANERS-NON POUROUS SURFACES:

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.

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. Masonry
    c. 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. Porcelain enamel
    d. 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 and 38 degrees C (40 and 100 degrees 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, fire rated, or smoke barrier 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 LOCATIONS:

A. Exterior Building Joints, Horizontal and Vertical:

1. Metal to Metal: Type S-1, S-2
2. Metal to Masonry or Stone: Type S-1
3. Masonry to Masonry or Stone: Type S-1
4. Stone to Stone: Type S-1
5. Cast Stone to Cast Stone: Type S-1
6. Threshold Setting Bed: Type S-1, S-3, S-4
7. Masonry Expansion and Control Joints: Type S-6
8. Wood to Masonry: Type S-1

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. Counter Tops to Walls: Type S-9
3. Pipe Penetrations: Type S-9

D. High Temperature Joints over 204 degrees C (400 degrees F):

1. Exhaust Pipes, Flues, Breech Stacks: Type S-7 or S-8

E. Interior Caulking:

1. Typical Narrow Joint 6 mm, (1/4 inch) or less at Walls and Adjacent Components: Types C-1, C-2 and C-3
2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Masonry Surfaces: Types C-1, C-2 and C-3
3. Joints at Masonry Walls and Columns, Piers, Concrete Walls or Exterior Walls: Types C-1, C-2 and C-3
4. Perimeter of Lead Faced Control Windows and Plaster or Gypsum Wallboard Walls: Types C-1, C-2 and C-3
5. Exposed Isolation Joints at Top of Full Height Walls: Types C-1, C-2 and C-3
6. Exposed Acoustical Joint at Sound Rated Partitions Type C-2
7. Concealed Acoustic Sealant Type S-4, C-1, C-2 and C-3

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SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies steel doors with louvers, 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. Door Hardware: Section 08 71 00, DOOR HARDWARE

1.3 TESTING

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.

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. Door and Hardware Institute (DHI):

A115 Series................................Steel Door and Frame Preparation for Hardware, Series A115.1 through A115.17 (Dates Vary)

C. Steel Door Institute (SDI):

A250.8-03..................................Standard Steel Doors and Frames

D. American Society for Testing and Materials (ASTM):

A167-99(R2004)........................Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

A568/568-M-07 ....Steel, Sheet, Carbon, and High-Strength, Low-alloy, Hot-Rolled and Cold-Rolled

A1008-08...................................Steel, sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy and High Strength Low Alloy with Improved Formability

B209/209M-07............................Aluminum and Aluminum-Alloy Sheet and Plate

B221/221M-08............................Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes

D1621-04 ....Compressive Properties of Rigid Cellular Plastics

E90-04.......................................Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions

E. The National Association Architectural Metal Manufacturers (NAAMM):
Metal Finishes Manual (1988 Edition)

1.8 WARRANTY

Construction Warranty: FAR clause 52.246-21, "Warranty of Construction"

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.

C. Prime Paint: Paint that meets or exceeds the requirements of A250.8.

2.2 FABRICATION GENERAL

A. GENERAL:
   1. Follow SDI A250.8 for fabrication of standard steel doors, except as specified otherwise. Doors to receive hardware specified in Section 08 71 00, DOOR HARDWARE. Tolerances as per SDI A250.8. Thickness, 44 mm (1-3/4 inches), unless otherwise shown.
   2. Close top edge of doors flush and seal to prevent water intrusion.
   3. When vertical steel stiffeners are used for core construction, fill spaces between stiffeners with mineral fiber insulation.

B. 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.

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. Face welded. Knock-down frames shall not be acceptable.

B. Reinforcement and Covers:
   1. SDI A250.8 for, minimum thickness of steel reinforcement welded to back of frames.

C. Frame Anchors:
   1. Floor anchors:
      a. 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.

b. 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 600 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 or clips for securing anchor to the sides of the studs.

2.4 SHOP PAINTING

SDI A250.8

2.5 LOUVERS

A. General:
   1. Sight proof type with stationary blades the full thickness of the door.
B. Fabrication:
   1. Steel louvers 1.3 mm (0.053 inch) inch thick for all doors where indicated.
   2. Fabricate louvers as complete units. Install in prepared cutouts in doors.
   3. Weld stationary blades to frames. Weld louvers into door openings.

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.
   2. Power actuated drive pins may be used to secure frame anchors to concrete floors.
C. Jamb Anchors:
   1. Secure anchors to sides of studs by welding or with two fasteners through anchor tabs. Use steel drill screws to steel studs.

D. Insulation:

1. Pack insulation around door frames and windows and in cracks, expansion joints, control joints, door soffits and other voids.
2. Do not compress insulation below required thickness except where embedded items prevent required thickness.

3.2 INSTALLATION OF DOORS AND APPLICATION OF HARDWARE

Install doors and hardware as specified in Sections 08 11 13 and 08 71 00.

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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

C. Finishes: See Drawings.

D. Painting: Section 09 91 00, PAINTING

E. Electrical: Division 26, ELECTRICAL

1.3 GENERAL

A. All hardware shall comply with ABAAS, (Architectural Barriers Act Accessibility 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 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.

D. The following items shall be of the same manufacturer, if possible, except as otherwise specified:

1. Hinges for hollow metal doors
2. Surface applied overhead door closers

E. Where exact types of hardware specified are not adaptable to finished shape or size of members requiring hardware, provide suitable types having as nearly as practical the same operation and quality as type specified, subject to Project Engineer's approval.

F. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents. Furnish related trades with the following information:

1. Location of embedded and attached items to concrete.
2. Location of wall-mounted hardware, including wall stops.
3. Location of finish floor materials and floor-mounted hardware.
4. Manufacturer templates to door and frame fabricators.

G. Check Shop Drawings and field verify for doors to confirm that adequate provisions will be made for proper hardware installation.

1.4 WARRANTY

A. Door closers and hinges: 10 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.	UL Mark (if fire rated and listed)	ANSI/BHMA Finish Designation

C. 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.

D. 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 and instructions. Tag one of each different item of hardware and deliver to Project Engineer for reference purposes. Tag shall identify items by Project Specification number and manufacturer's catalog number. These items shall remain on file in Project Engineer's office until all other similar items have been installed in project, at which time the Project 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, mutes, 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:

McKinney	Assa Abloy	New Haven, CT
Norton	Assa Abloy	Monroe, NC
Rockwood	Assa Abloy	Rockwood, PA
Zero	Zero International	Bronx, NY

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):

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):

A156.1-06..................................Butts and Hinges
A156.4-08..................................Door Controls (Closers)
A156.6-05..................................Architectural Door Trim
A156.16-08................................Auxiliary Hardware
A156.18-06................................Materials and Finishes
A156.21-09................................Thresholds
A250.8-03..................................Standard Steel Doors and Frames

D. Door and Hardware Institute

E. National Fire Protection Association (NFPA):

101-09 ....Life Safety Code

F. Underwriters Laboratories, Inc. (UL):

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. Interior Doors: Type TA2314 for doors 900 mm (3 feet) wide or less. Hinges for doors exposed to high humidity areas (shower rooms, toilet rooms, kitchens, janitor rooms, etc. shall be of stainless steel material.

B. Provide quantity and size of hinges per door leaf as follows:

   1. Doors 1210 mm (4 feet) to 2260 mm (7 feet 5 inches) high: 3 hinges minimum.
   2. 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.

C. Drawings typically depict doors at 90 degrees, doors will actually swing to maximum allowable. Use continuous hinges to allow door to stand parallel to wall for true 180-degree opening.

D. Conform to manufacturer’s published hinge selection standard for door dimensions, weight and frequency, and to hinge selection as scheduled. Where manufacturer’s standard exceeds the scheduled product, furnish the heavier of the two choices, notify Project Engineer of deviation from scheduled hardware

2.2 DOOR CLOSING DEVICES

A. Closing devices shall be products of one manufacturer for each type specified.

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 ½" (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.

C. Wall bumpers, where used, must be installed to impact the trim or the door within the leading half of its width.

D. Provide appropriate door mounted stop on doors in individual toilets where floor or wall mounted stops cannot be used.

E. Where the specified wall stop cannot be used, provide concealed overhead stops (surface-mounted where concealed cannot be used).

2.5 KICK PLATES AND DOOR EDGING

A. Conform to ANSI Standard A156.6.

B. Provide protective plates and door edging as specified below:

1. Kick plate, of metal, 1050 series.
2. Provide kick plates where specified. Kick plates shall be 254 mm (10 inches) or 305 mm (12 inches) high. Kick plates shall be minimum 1.27 mm (0.050 inches) thick. Provide kick 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. Extend all other kick plates to within 6 mm (1/4 inch) of each edge of doors. Kick plates shall butt astragals. For jamb stop requirements, see specification sections pertaining to door frames.

2.6 THRESHOLDS

A. Thresholds shall be installed in a full bed of sealant with ¼-20 stainless steel machine screws and expansion shields. Furnish thresholds for the full width of the openings and cope ends around door stops.

B. At 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 frame face.

2.7 MISCELLANEOUS HARDWARE

A. Mutes: Conform to ANSI A156.16. Provide door mutes or door silencers of light gray color, on each steel door frame. Furnish 3 mutes for single doors.

2.8 FINISHES

A. Exposed surfaces of hardware shall have ANSI A156.18, finishes as specified below. Finishes on all hinges, 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 interior of buildings, except where other finishes are specified.

C. Miscellaneous Finishes:

1. Hinges at interior doors: 652 or 630
2. Door Closers: Factory applied paint finish 689; Dull or Satin Aluminum color
3. Thresholds: Clear anodized aluminum with epoxy abrasive strips

D. Hardware Finishes for Existing Buildings: U.S. Standard finishes shall match finishes of hardware in (similar) existing spaces.

E. Anti-microbial Coating: All hand-operated hardware (levers, pulls, push bars, push plates, paddles, and panic bars) shall be provided with an anti-microbial/anti-fungal coating that has passed ASTM E2180 tests. Coating to consist of ionic silver (Ag+). Silver ions surround bacterial cells, inhibiting growth of bacteria, mold, and mildew by blockading food and respiration supplies.

2.9 BASE METALS

A. Apply specified U.S. Standard finishes on different base metals as following:

Finish	Base Metal
626	Brass or bronze
630	Stainless steel
652	Steel

PART 3 - EXECUTION

3.1 HARDWARE HEIGHTS

A. For existing buildings locate hardware on doors at heights to match existing hardware. The Contractor shall visit the site, verify location of existing hardware and submit locations to VA Project Engineer for approval.

1. Contractor to install all door hardware in conformance to ABAAS accessibility requirements, between 864 and 1117 mm (34 and 44 inches) above finish floor elevation.

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, and away from corridors.

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)

C. Hinge leaves shall be sufficiently wide to allow doors to swing clear of door frame trim and surrounding conditions.

D. Existing hinges shall not be reused on door openings having new doors and new frames. Coordinate preparation for hinge cut-outs and screw-hole locations on doors and frames.

E. Hinges Required Per Door:

Doors over 1500 mm (5 ft) high and not over 2280 mm (7 ft 6 in) high	3 butts

F. Fastenings: Suitable size and type and shall harmonize with hardware as to material and finish. Fiber or rawl plugs and adhesives are not permitted.

3.3 FINAL INSPECTION

A. Installer to provide letter to VA 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, including adjustment and maintenance procedures, to satisfaction of 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.

HW SET: 1 (Door D-1)

Door 103: NON-RATED

3 EA	Hinge	McKinney	TA2314 x 4.5 x 630
1 EA	Closer	Norton	R7500 x SNB x 689
1 EA	Threshold	Zero	545A-E (clear anodized with epoxy abrasive)
1 EA	Push Plate	McKinney	70E 6 x 16 x 630
1 EA	Pull Plate	McKinney	BF110 x 70C x 630
1 EA	Kick Plate	McKinney	1050 x 10”x34” x CSK x B4E x 630
1 EA	Mop Plate	McKinney	K1050 x 10”x34” x CSK x B4E x 630
1 EA	Wall Stop	McKinney	400 x 630
3 EA	Silencers	McKinney	608 x Gray

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SECTION 08 91 00
STATIONARY BLADE WALL LOUVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Extruded aluminum, wind driven rain resistant stationary combustion air intake louvers with horizontally mounted sight proof blades, to be mounted in existing steel window frames after removal of existing glazing at designated locations.

1.2 RELATED SECTIONS

A. Section 01 81 11 – Sustainable Design Requirements

B. Section 07 92 00 - Joint Sealants

1.3 REFERENCES

A. AAMA 2604……………………High Performance Organic Coatings on Architectural Extrusions and Panels

B. AAMA 2605……………………High Performance Organic Coatings on Architectural Extrusions and Panels

C. AAMA 611……………………..Voluntary Specification for Anodized Architectural Aluminum

D. AMCA 500……………………..Test Methods for Louvers, Dampers and Shutters

E. AMCA 511……………………..Certified Ratings Program for Air Control Devices

F. ASCE 7………………………...Minimum Design Loads for Buildings and Other Structures

G. ASTM B209………………….. Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

H. ASTM B221………………….. Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

I. ASTM D822…………………...Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

J. ASTM D4214………………… Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

K. ASTM D2244………………… Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates

1.4 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

D. Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.5 ACTION SUBMITTALS

A. Submit under provisions of Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Product Data: For each product to be used, including:

1. Manufacturer's product data including performance data
2. Preparation instructions and recommendations
3. Storage and handling requirements and recommendations
4. Installation methods

C. Shop Drawings:

1. Submit shop drawings indicating materials, construction, dimensions, accessories, and installation details.

D. Product Schedule: For louvers. Use same designations indicated on Drawings.

E. Samples: Submit sample of louver to show frame, blades, bird screen, gutters, downspouts, vertical supports, sill, accessories, finish, and color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer

B. Product Test Reports: For each type of louver, for tests performed by a qualified testing agency.

C. Field quality-control reports

D. Sample Warranties: For manufacturer's warranties

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. The manufacturer shall have implemented the management of quality objectives, continual improvement, and monitoring of customer satisfaction to assure that customer needs and expectations are met.
2. Manufacturer shall be International Organization for Standardization (ISO) 9001 accredited.

B. Product Qualifications:

1. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.
2. Louvers shall be factory engineered to withstand the specified seismic loads.
   a. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ).
3. Louvers shall be compatible with installation in existing steel framed window sash.
   a. Field verify required configuration, provide shop drawings.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store materials in a dry area indoors, protected from damage and in accordance with manufacturer's instructions.

C. Handling: Protect materials and finishes during handling and installation to prevent damage.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.10 WARRANTY

A. Manufacturer shall provide standard limited warranty for louver systems for a period of one year from date of installation, no more than 18 months after shipment from manufacturing plant. When notified in writing from the Owner of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to the Owner.

B. Manufacturer shall provide 20 year limited warranty for fluoropolymer-based finish on extruded aluminum substrates.

Finish coating shall not peel, blister, chip, crack or check.

Chalking, fading or erosion of finish when measured by the following tests:

a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.

b. Finish coating shall not change color or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.

c. Finish coating shall not erode at a rate in excess of 10%/ 5 year as determined by Florida test sample.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Ruskin Company; 3900 Dr. Greaves Road, Kansas City, Missouri 64030. Tel: (816) 761-7476.

B. Products of other manufacturers satisfying there requirements of this specification shall be acceptable.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

2.2 STATIONARY BLADE LOUVER

A. Model: EME220DD as manufactured by Ruskin Company or accepted alternate.

B. Fabrication: Extruded aluminum stationary horizontal chevron louver style.

1. Design: Double drainable blades shall be contained within the frame with double downspouts in jambs and mullions. Louver design shall limit span between visible mullions to 3048 mm (120 inches).
2. Frame:
   a. Frame Depth: 50 mm (2 inches)
   b. Material: Extruded aluminum, Alloy 6063-T6
   c. Wall Thickness: 1.5 mm (0.060 inch), nominal
3. Blades:
   a. Style: Horizontal
   b. Material: Extruded aluminum, Alloy 6063-T6
   c. Exterior Wall Thickness: 1.1 mm (0.045 inch), nominal
4. Fabrication:
   a. Mullion Style – Design incorporates visible mullions or frames at the perimeter of the louver and also at certain intervals within the louver perimeter to support the louver blades. Louver blade sightlines are interrupted at the mullion locations. No rear-mounted blade supports are utilized.
5. Minimum assembly size: 152 mm x 152 mm (6 inches wide by 6 inches high)
6. Maximum Factory Assembly Size: Single sections shall not exceed 3048 mm x 2286 mm (120 inches wide by 90 inches high) or 2286 mm x 3048 (90 inches wide by 120 inches high). Louvers larger than the maximum single size shall be require field assembly of smaller sections.
7. Recycled Content: 18% post-consumer. 55% pre-consumer, post-industrial, total 73% by weight.

C. Performance Data:
1. Performance Ratings: AMCA licensed
   a. Based on testing 1219 mm by 1219 mm (48 inch by 48 inch) size unit in accordance with AMCA 500.
2. Free Area: 43 percent, nominal
3. Free Area Size: 0.64 sm (6.86 sf)
4. Maximum Recommended Air Flow through Free Area: 3.5 m/s (680 feet per minute)
5. Air Flow: 2.2 m^3/s (4665 cubic feet per minute)

D. Wind Driven Water Penetration Performance:
1. Based on testing 1 m x 1 m (39 inches x 39 inches) core area, 1.04 m x 1.12 m (41 inches x 44 inches) nominal size unit in accordance with AMCA 500-L.
2. Wind Velocity: 47 kph (29 mph)
   a. Rainfall Rate: 76 mm/hour (3 inches/hour)
   b. Free Area Velocity: 6.1 m/sec (1209 feet per minute)

c. Water Resistance Effectiveness: 99.3% (AMCA Class A)

3. Wind Velocity: 80 kph (50 mph)
    a. Rainfall Rate: 203 mm/hour (8 inches/hour)
    b. Free Area Velocity: 3.8 m/sec (757 feet per minute)
    c. Water Resistance Effectiveness: 99.3% (AMCA Class A)

E. Design Windload: Wind load acting inward or outward of not less than 1436 Pa (30 lb. per sq. ft.).

F. Louvers shall be factory engineered to withstand the specified seismic loads.
    1. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction (AHJ).

2.3 ACCESSORIES

A. Aluminum Blank-Off Panels: 1 mm (0.040 inch) aluminum sheet, factory installed with removable fasteners and neoprene gaskets.

B. Filter Racks: Formed channel racks to accept standard 25 mm (1 inch) thick filters. Unused bottom portion blanked off with 1 mm (0.040 inch) aluminum sheet.

C. Security Bars:
    1. Location: Front
    2. Construction: Aluminum, 19 mm x 13 mm (3/4 inch x 1/2 inch), welded to louver; or;
    3. Construction: Galvanized steel, 19 mm x 13 mm (3/4 inch x 1/2 inch), attached to louver with tamper-proof screws.

D. Insect Screens:
    1. Aluminum: 18-16 mesh, mill finish, 0.3 mm (0.011 inch) wire.
    2. Frame: Aluminum.

E. Visible Mullions: Manufacturer's standard horizontal or vertical visible mullions for architectural accent as indicated on drawings.

2.4 FINISHES

A. Finish: 70 percent PVDF: Finish shall be applied at 0.03 mm (1.2 mil total dry film thickness.
    1. Coating shall conform to AAMA 2605. Apply coating following cleaning and pretreatment. Cleaning: AA-C12C42R1X.
        a. Standard 2-coat.
    2. 20-year finish warranty.

    Or;

B. Anodized Finish:
    1. Class I Clear Anodized.
        a. Comply with Aluminum Association AA-C21A41. Clear anodized finish 215-R1.
        b. Apply finish following chemical etching and pretreatment.
        c. Minimum Thickness: 0.018 mm (0.7 mils), 60 minute anodizing process.

Or;

2. Class I Color Anodized.
    a. Comply with Aluminum Association AA-C21A44.
    b. Apply finish following chemical etching and pretreatment.
    c. Minimum Thickness: 0.018 mm (0.7 mils), 60 minute anodizing process.
    d. Class I Color Anodized: Medium Bronze.
    e. Class I Color Anodized: Dark Bronze.
    f. Class I Color Anodized: Black.

2.5 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 coating (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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas to receive louvers. Notify the Architect of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.

B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean opening thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.

B. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

C. Install joint sealants as specified in Section 07 92 00.

3.4 CLEANING

A. Clean louver surfaces in accordance with manufacturer's instructions.

B. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Contracting Officer Representative (COR) damaged units and replace with new units.

- - - END - - -

SECTION 09 06 00
COLOR AND DESIGN

PART 1 -GENERAL

1.1 DESCRIPTION:

This section includes physical data requirements for materials specified and shown on the drawings.

1.2 RELATED WORK:

Refer to specific items identified.

1.3 MANUFACTURER'S REQUIREMENT:

Refer to "Manufacturers Qualifications" for specific requirements.

1.4 SUBMITTALS:

In accordance with Section 01 33 23, SAMPLES AND SHOP DRAWING, furnish the following:

A. Shop Drawing:

1. Where specifically requested, shop drawing will be submitted identifying all parts by name, kind of material and showing construction, installation and anchorage.

B. Manufacturer's Literature & Data Sheets:

1. Indicating manufacturer's qualifications, physical data and warranties.

PART 2 - MATERIALS

2.1 SCHEDULE OF FINISHES

MATERIAL	SPEC SECTION	PRODUCT DESCRIPTION / MFR	CONTACT	NOTES	LOCATION
PAINT					
Notes: Semigloss required at all Wet Areas					
PT-1	099100_1	**Paint Type 1:** MFR: DUNN EDWARDS Type: Semi-Gloss Color: DEW339 Bone China	DUNN EDWARDS Larry Loo larry.loo@dunnedwards.com 323.826.2650	See Section 099100 for Paint Specification	Interior Walls of Office, Repaired Walls at Locker Room and Restroom

PT-2	099100_2	**Paint Type 2** MFR: DUNN EDWARDS Type: Color: DE6227 Muslin	DUNN EDWARDS Larry Loo larry.loo@dunnedwards.com 323.826.2650		Hollow Metal Doors and Frames, Concrete Walls
PT-3	099100_3	**Paint Type 3:** MFR: DUNN EDWARDS Type: Color: DE6228 Play on Gray	DUNN EDWARDS Larry Loo larry.loo@dunnedwards.com 323.826.2650		Ferrous Metal Columns, Railing Catwalks, Stairs, Electrical Conduit Vents, Corrugated Metal Deck, Non Ferrous Metal
PT-4	099100_4	**Paint Type 4:** MFR: DUNN EDWARDS Type: Color: DEA156 Cherry Cola	DUNN EDWARDS Larry Loo larry.loo@dunnedwards.com 323.826.2650		Ferrous Metal Beams, Truss
PT-6	099100_6	**Paint Type 6:** MFR: DUNN EDWARDS Type: Semi Gloss Color: DE6229 Calico Rock	DUNN EDWARDS Larry Loo larry.loo@dunnedwards.com 323.826.2650		Ferrous Metal Structural Steel
PT-9	099100_7	**Paint Type 9:** MFR: Rust-Oleum Type: SC9100 System 100 VOC DTM Epoxy Mastic Color: Match PT-3	RUST-OLEUM 847.367.7700		Concrete Floor
RUBBER BASE					
RB-1	096513_1	**Rubber Base Type 1:** MFR: Johnsonite Type: Tightlock Wallbase,Resilient 4.375" Color:20 Charcoal	Johnsonite Contact: Ellen Wren ellen.wren@johnsonite.com 323.876.3801	Cove Base for Resilient Flooring	4.375" Base Typical Office, Balcony
RB-2	096513_2	**Rubber Base Type 2:** MFR: Johnsonite Type: Tightlock Wallbase, Resilient 4.375" Color: 80 Fawn	Johnsonite Contact: Ellen Wren ellen.wren@johnsonite.com 323.876.3801		4.375" Base Typical Locker Room, Restroom

RESILIENT FLOORING					
RSF-1	096513_1	**Resilient Flooring Type 1:** MFR: Johnsonite Style: Definant Rubber Tile Color: 729 Thicket	Johnsonite Heather Vari hevari@armstrong.com 562.619.7831	24"x24" Tile	Office, Balcony
RSF-2	096513_2	**Resilient Flooring Type 2:** MFR: Johnsonite Style: Definant Sheet Rubber Flooring Color: 732 Tundra	Johnsonite Heather Vari hevari@armstrong.com 562.619.7831	Sheet Flooring	Office, Balcony Locker Room, Restroom

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SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies steel studs wall systems, fasteners, and accessories for the screw attachment of gypsum board.

1.2 RELATED WORK

A. Load bearing framing: Section 05 40 00, COLD-FORMED METAL FRAMING.

B. Support for wall mounted items: Section 05 50 00, METAL FABRICATIONS.

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. Shop Drawings:

1. Typical metal stud and furring construction system including details around openings and corner details.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

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)

A123-09.....................................Zinc (Hot-dip Galvanized) Coatings on Iron and Steel Products

A653/A653M-09	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
A641-09	Zinc-Coated (Galvanized) Carbon Steel Wire
C11-10	Terminology Relating to Gypsum and Related Building Materials and Systems
C635-07	Manufacture, Performance, and Testing of Metal Suspension System for Acoustical Tile and Lay-in Panel Ceilings
C636-06	Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
C645-09	Non-Structural Steel Framing Members
C754-09	Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
C841-03(R2008)	Installation of Interior Lathing and Furring
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
C1002-07	Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
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

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. Provide not less than two cutouts in web of each stud, approximately 300 mm (12 inches) from each end, and intermediate cutouts on approximately 600 mm (24-inch) centers.

C. Doubled studs for openings and studs for supporting concrete backer-board.

D. Studs 3600 mm (12 feet) or less in length shall be in one piece.

2.3 FASTENERS, CLIPS, AND OTHER METAL ACCESSORIES

A. ASTM C754, except as otherwise specified.

B. 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.

C. Clips: ASTM C841 (paragraph 6.11), manufacturer’s standard items. Clips used in lieu of tie wire shall have holding power equivalent to that provided by the tie wire for the specific application.

PART 3 - EXECUTION

3.1 INSTALLING STUDS

A. Install studs in accordance with ASTM C754, except as otherwise shown or specified.

B. Space studs not more than 610 mm (24 inches) on center.

C. 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.

D. Where studs are shown to terminate above suspended ceilings, provide bracing as shown or extend studs to underside of structure overhead.

E. 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. Locate splice plates at 600 mm (24 inches) on center between runner tracks.

F. 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.

3.2 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.)

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies installation and finishing of gypsum board.

1.2 RELATED WORK

A. Installation of steel framing members for walls Section 09 22 16, NON-STRUCTURAL METAL FRAMING.

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. Shop Drawings:
   1. Typical gypsum board installation, showing corner details, edge trim details and the like.

D. Samples:
   1. Cornerbead.
   2. Edge trim.
   3. Control joints.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

In accordance with the requirements of ASTM C840.

1.6 ENVIRONMENTAL CONDITIONS

In accordance with the requirements of ASTM C840.

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):

C11-08 .... Terminology Relating to Gypsum and Related Building Materials and Systems

C475-02 .... Joint Compound and Joint Tape for Finishing Gypsum Board

C840-08 .... Application and Finishing of Gypsum Board

C919-08 .... Sealants in Acoustical Applications

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. (2.84mm) in thickness

C1002-07 .... Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

C1047-05 .... Accessories for Gypsum Wallboard and Gypsum Veneer Base

C1177-06 .... Glass Mat Gypsum Substrate for Use as Sheathing

C1658-06 .... Glass Mat Gypsum Panels

C1396-06 .... Gypsum Board

E84-08.. Surface Burning Characteristics of Building Materials

C. Underwriters Laboratories Inc. (UL):

Latest Edition .... Fire Resistance Directory

D. Inchcape Testing Services (ITS):

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.

2.2 ACCESSORIES

A. ASTM C1047, except form of 0.39 mm (0.015 inch) thick zinc coated steel sheet or rigid PVC plastic.

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. Clips: Zinc-coated (galvanized) steel; gypsum board manufacturer's standard items.

2.5 FINISHING MATERIALS AND LAMINATING ADHESIVE

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 GYPSUM BOARD HEIGHTS

A. Extend all layers of gypsum board from floor to underside of structure overhead on following partitions and furring:
    1. Two sides of partitions:
        a. Full height partitions shown (FHP).

B. In locations other than those specified, extend gypsum board from floor to heights as follows:
    1. Not less than 100 mm (4 inches) above suspended acoustical ceilings.
    2. At ceiling of suspended gypsum board ceilings.
    3. At existing ceilings.

3.2 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. Walls (Except Shaft 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. For two-ply gypsum board assemblies, apply base ply of gypsum board to assure minimum number of joints in face layer. Apply face ply of wallboard to base ply so that joints of face ply do not occur at joints of base ply with joints over framing members.

6. For three-ply gypsum board assemblies, apply plies in same manner as for two-ply assemblies, except that heads of fasteners need only be driven flush with surface for first and second plies. Apply third ply of wallboard in same manner as second ply of two-ply assembly, except use fasteners of sufficient length enough to have the same penetration into framing members as required for two-ply assemblies.
7. No offset in exposed face of walls and partitions will be permitted because of single-ply and two-ply or three-ply application requirements.

G. 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.

3.3 FINISHING OF GYPSUM BOARD

A. Finish joints, edges, corners, and fastener heads in accordance with ASTM C840. Use Level 5 finish for al finished areas open to public view.

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 Sanding is not required of non decorated surfaces.

3.4 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 // smoke tight construction // fire protection equivalent to the fire rated construction // and STC equivalent to the sound rated construction //.

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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 base.

1.2 RELATED WORK

A. Color and pattern and location in room finish schedule: 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. Description of each product.
2. Base and stair material manufacturer's recommendations for adhesives.
3. Application and installation instructions.

C. Samples:

1. Base: 150 mm (6 inches) long, each type and color.
2. Resilient Stair Treads: 150 mm (6 inches) long.
3. Sheet Rubber Flooring: 300 mm (12 inches) square.
4. 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):

F1861-02....................................Resilient Wall Base

PART 2 - PRODUCTS

2.1 GENERAL

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, rubber and vinyl cover wall base.

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 21º C (70 °F), for 48 hours before installation.

B. Maintain temperature of rooms where work occurs, between 21º C and 27º C (70ºF and 80ºF) 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 surface on which material is to be installed.
B. Fill cracks, pits, and dents with leveling compound.
C. Level to 3mm (1/8 inch) maximum variations.
D. Do not use adhesive for leveling or 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.
H. Preparation of existing installation:
   1. Remove existing base including adhesive.
   2. Do not use solvents to remove adhesives.
   3. Prepare substrate as specified.

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.

3.4 CLEANING AND PROTECTION

A. Clean all exposed surfaces of base and adjoining areas of adhesive spatter before it sets.

B. Keep traffic off resilient material for at least 72 hours after installation.

C. Clean and polish materials in the following order:

1. After two weeks, scrub resilient base with a minimum amount of water and a mild detergent. Leave surfaces clean and free of detergent residue. Polish resilient base to a gloss finish.

2. Do not polish tread and sheet rubber materials.

D. When construction traffic is anticipated, cover tread materials with reinforced kraft paper and plywood or hardboard properly secured and maintained until removal is directed by the Resident Engineer.

E. 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.

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SECTION 09 65 16
RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the installation of sheet flooring with backing.

B. Grades of resilient sheet vinyl floor covering without backing having vinyl plastic wearlayer with backing.

C. Installation of sheet flooring including following:

1. Heat welded seams.

1.2 RELATED WORK

A. Concrete floors: Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Color, pattern and texture: Section 09 06 00, SCHEDULE FOR FINISHES.

C. Unbacked vinyl (homogenous) sheet flooring with welded seams: Section 09 65 16, RESILIENT SHEET FLOORING.

1.3 QUALITY CONTROL-QUALIFICATIONS:

A. The Contracting Officer shall approve products or service of proposed manufacturer, suppliers, and installers, and the Contractor shall submit certification that:

1. Heat welded seaming is manufacturer's prescribed method of installation.
2. Installer is approved by manufacturer of materials and has technical qualifications, experience, trained personnel, and facilities to install specified items.
3. Manufacturer's product submitted has been in satisfactory operation, on three installations similar and equivalent in size to this project for three years. Submit list of installations.

B. The sheet vinyl floor coverings shall meet fire performance characteristics as determined by testing products, per ASTM test method, indicated below by Underwriters Laboratories, Inc. (UL) or another recognized testing and inspecting agency acceptable to authorities having jurisdiction.

1. Critical Radiant Flux: 0.45 watts per sq. cm or more, Class I, per ASTM E648.
2. Smoke Density: Less than 450 per ASTM E662.

C. The floor covering manufacturer shall certify that products supplied for installation comply with local regulations controlling use of volatile organic compounds (VOC’s).

1.4 SUBMITTALS

A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, submit following:

B. Manufacturer's Literature and Data:

1. Description of resilient material and accessories to be provided.
2. Resilient material manufacturer's recommendations for adhesives, weld rods, sealants, and underlayment.

3. Application and installation instructions.

C. Samples:

1. Sheet material, 38 mm by 300 mm (1-1/2 inch by 12 inch), of each color and pattern with a welded seam using proposed welding rod 300 mm (12 inches) square for each type, pattern and color.
2. Shop Drawings and Certificates: Layout of joints showing patterns where joints are expressed, and type and location of obscure type joints. Indicate orientation of directional patterns.
3. Certificates: Quality Control Certificate Submittals and lists specified in paragraph, QUALIFICATIONS.
4. Adhesive, underlayment and primer: Pint container, each type.

1.5 PROJECT CONDITIONS

A. Maintain temperature of floor materials and room, where work occurs, above 18 ° C (65 °F) and below 38 °C (100 °F) for 48 hours before, during and for 48 hours after installation. After above period, room temperature shall not fall below 13 °C (55 °F).

B. Construction in or near areas to receive flooring work shall be complete, dry and cured. Do not install resilient flooring over slabs until they have been cured and are sufficiently dry to achieve a bond with adhesive. Follow flooring manufacturer’s recommendations for bond and moisture testing.

C. Building shall be permanently enclosed. Schedule construction so that floor receives no construction traffic when completed.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site in original sealed packages or containers; labeled for identification with manufacturer's name and brand.

B. Deliver sheet flooring full width roll, completely enclosed in factory wrap, clearly marked with the manufacturer's number, type and color, production run number and manufacture date.

C. Store materials in weathertight and dry storage facility. Protect from damage due to handling, weather, and construction operations before, during and after installation. Store sheet flooring on end with ambient temperatures maintained as recommended by manufacturer.

D. Store sheet flooring on end.

E. Move sheet vinyl floor coverings and installation accessories into spaces where they will be installed at least 48 hours in advance of installation.

1.7 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 Materials (ASTM):

E648-09 .... Critical Radiant Flux of Floor-Covering Systems Using a Radiant Energy Source

E662-09 .... Specific Optical Density of Smoke Generated by Solid Materials

F710-08 .... Practice for Preparing Concrete Floors and Other Monolithic Floors to Receive Resilient Flooring

F1303-04 .... Sheet Vinyl Floor Covering with Backing

F1869-04 .... Moisture Vapor Emission Rate of Concrete Subfloor using Anhydrous Calcium Chloride

F1913-04 .... Sheet Vinyl Flooring without Backing

F2170-09 .... Determining Relative Humidity in Concrete Floor Slabs using In-situ Probes

C. Resilient Floor Covering Institute (RFCI):

Recommended Work Practices for Removal of Resilient Floor Coverings.

1.8 SCHEDULING

Interior finish work such as plastering, drywall finishing, concrete, terrazzo, ceiling work, and painting work shall be complete and dry before installation. Mechanical, electrical, and other work above ceiling line shall be completed. Heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

1.9 WARRANTY:

Submit written warranty, in accordance with FAR clause 52.246-21, Warranty of Construction requirements except that warranty period shall be extended to include two (2) years.

PART 2 - PRODUCTS

2.1 SHEET VINYL FLOOR COVERINGS

A. Sheet Vinyl Floor Coverings: Smooth face, minimum thickness nominal 2 mm (0.08 inch). Sheet flooring shall conform to ASTM F1913 and material requirements specified in ASTM F1303, Type II, Grade 1, backing classification not applicable. Foam backed sheet flooring is not acceptable.

B. Size: Provide maximum size sheet vinyl material produced by manufacturer to provide minimum number of joints. Minimum size width acceptable - 1200 mm (48 inches).

C. Each color and pattern of sheet flooring shall be of same production run.

2.2 WELDING ROD:

Product of floor covering manufacturer in color shall match field color of sheet vinyl covering.

2.3 APPLICATION MATERIALS AND ACCESSORIES

A. Floor and Base Adhesive: Type recommended by sheet flooring material manufacturer for conditions of use.

B. Mastic Underlayment (for concrete floors): Provide products with latex or polyvinyl acetate resins in mix. Condition to be corrected shall determine type of underlayment selected for use.

2.4 SHEET FLOORING

A. ASTM F1303, Type II, Grade 1, except for backing requirements. Foam backed sheet flooring is not acceptable.

B. Minimum nominal thickness 2 mm (0.08 inch); 1800 mm (6 feet) minimum width.

C. Critical Radiant Flux: 0.45 watts per sq.cm or more, Class I, per ASTM E648.

D. Smoke density: less than 450 per ASTM E662.

E. Color and pattern of sheet flooring of the same production run.

2.5 ADHESIVES

Water resistant type recommended by the sheet flooring manufacturer for the conditions of use. VOC not to exceed 50 g/L.

2.6 LEVELING COMPOUND (FOR CONCRETE FLOORS)

Provide cementitious products with latex or polyvinyl acetate resins in the mix.

2.7 PRIMER (FOR CONCRETE SUBFLOORS)

As recommended by the adhesive or sheet flooring manufacturer.

2.8 SEALANT

A. As specified in Section 07 92 00, JOINT SEALANTS.

B. Compatible with sheet flooring.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

A. Maintain temperature of sheet flooring above 19 degrees C (65 degrees F), for 48 hours before installation.

B. Maintain temperature of rooms where sheet flooring work occurs above 19 degrees C (65 degrees F), for 48 hours, before installation and during installation.

C. After installation, maintain temperature at or above 19 degrees C (65 degrees F.)

D. Building is permanently enclosed.

E. Wet construction in or near areas to receive sheet flooring is complete, dry and cured.

3.2 SUBFLOOR PREPARATION

A. Concrete Subfloors: Verify that concrete slabs comply with ASTM F710.

1. Installer shall examine surfaces on which resilient sheet flooring is to be installed, and shall advise Contractor, in writing, of areas which are unacceptable for installation of flooring material. Installer shall advise Contractor which methods are to be used to correct conditions that will impair proper installation. Installation shall not proceed until unsatisfactory conditions have been corrected.

2. Slab substrates dry, free of curing compounds, sealers, hardeners, and other materials which would interfere with bonding of adhesive. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by Resilient Floor Covering Institute recommendations in manual RFCI-MRP.

B. Broom or vacuum clean substrates to be covered by sheet vinyl floor coverings immediately before installation. Following cleaning, examine substrates to determine if there is visually any evidence of moisture, alkaline salts, carbonation, or dust.

C. Primer: If recommended by flooring manufacturer, prior to application of adhesive, apply concrete slab primer in accordance with manufacturer’s directions.

D. Correct conditions which will impair proper installation, including trowel marks, pits, dents, protrusions, cracks or joints.

E. Fill cracks, joints, depressions, and other irregularities in concrete with leveling compound.

1. Do not use adhesive for filling or leveling purposes.
2. Do not use leveling compound to correct imperfections which can be corrected by spot grinding.
3. Trowel to smooth surface free of trowel marks, pits, dents, protrusions, cracks or joint lines.

F. Clean floor of oil, paint, dust and deleterious substances. Leave floor dry and cured free of residue from existing curing or cleaning agents.

G. Moisture Testing: Perform moisture and pH test as recommended by the flooring and adhesive manufacturers. Perform test locations starting on the deepest part of the concrete structure. Proceed with installation only after concrete substrates meet or exceed the manufacturer’s requirements. In the absence of specific guidance from the flooring or adhesive manufacturer the following requirements are to be met:

1. Perform moisture vapor emission tests in accordance with ASTM F1869. Proceed with installation only after substrates have a maximum moisture-vapor-emission rate of 1.36 kg of water/92.9 sq. m (3lb of water/1000 sq. ft.) in 24 hours.
2. Perform concrete internal relative humidity testing using situ probes in accordance with ASTM F2170. Proceed with installation only after concrete reaches maximum 75 percent relative humidity level measurement.

H. Preparation shall include the removal of existing resilient floor and existing adhesive. Do not use solvents to remove adhesives. Coordinate with Asbestos Abatement Section if asbestos abatement procedures will be involved.

I. Remove existing resilient flooring and adhesive completely in accordance with Resilient Floor Covering Institute recommendations in manual RFCI-WP. Solvents shall not be used.

3.3 INSTALLATION OF FLOORING

A. Install work in strict compliance with manufacturer's instructions and approved layout drawings.

B. Maintain uniformity of sheet vinyl floor covering direction and avoid cross seams.

C. Arrange for a minimum number of seams and place them in inconspicuous and low traffic areas, but in no case less than 150 mm (6 inches) away from parallel joints in flooring substrates.

D. Match edges of resilient floor coverings for color shading and pattern at seams.

E. Where resilient sheet flooring abuts other flooring material floors shall finish level.

F. Extend sheet vinyl floor coverings into toe spaces, door reveals, closets, and similar openings.

G. Inform the Project Engineer of conflicts between this section and the manufacturer's instructions or recommendations for auxiliary materials, or installation methods, before proceeding.

H. Install sheet in full coverage adhesives.

1. Air pockets or loose edges will not be accepted.
2. Trim sheet materials to touch in the length of intersection at pipes and vertical projections; seal joints at pipe with waterproof cement or sealant.

I. Keep joints to a minimum; avoid small filler pieces or strips.

J. Follow manufacturer’s recommendations for seams at butt joints. Do not leave any open joints that would be readily visible from a standing position.

K. Follow manufacturer’s recommendations regarding pattern match, if applicable.

3.4 WELDING

A. Heat weld all joints of flooring and base using equipment and procedures recommended by flooring manufacturer.

B. Welding shall consist of routing joint, inserting a welding rod into routed space, and terminally fusing into a homogeneous joint.

C. Upon completion of welding, surface across joint shall finish flush, free from voids, and recessed or raised areas.

D. Fusion of Material: Joint shall be fused a minimum of 65 percent through thickness of material, and after welding shall meet specified characteristics for flooring.

3.5 CLEANING

A. Clean small adhesive marks during application of sheet flooring and base before adhesive sets, excessive adhesive smearing will not be accepted.

B. Remove visible adhesive and other surface blemishes using methods and cleaner recommended by floor covering manufacturers.

C. Clean and polish materials per flooring manufacturer’s written recommendations.

D. Vacuum floor thoroughly.

E. Do not wash floor until after period recommended by floor covering manufacturer and then prepare in accordance with manufacturer’s recommendations.

F. Upon completion, Project Engineer shall inspect floor and base to ascertain that work was done in accordance with manufacturer's printed instructions.

G. Perform initial maintenance according to flooring manufacturer’s written recommendations.

3.6 PROTECTION:

A. Protect installed flooring as recommended by flooring manufacturer against damage from rolling loads, other trades, or placement of fixtures and furnishings.

B. Keep traffic off sheet flooring for 24 hours after installation.

C. Where construction traffic is anticipated, cover sheet flooring with reinforced kraft paper properly secured and maintained until removal is authorized by the Project Engineer.

D. Where protective materials are removed and immediately prior to acceptance, repair any damage, re-clean sheet flooring, lightly re-apply polish and buff floor.

- - - E N D - - -

Section 09 91 00
PAINTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The work includes, but is not necessarily limited to, furnishing of materials and equipment and completion of painting and painter's finish on exposed surfaces as required to complete finishing of all exterior and interior surfaces including:

Ferrous Metal	Non Ferrous Metal	Concrete
Gypsum Board		

B. Thoroughly examine specifications, site of work and conditions under which work will be performed before submitting a proposal. Surfaces which cannot be prepared or painted as specified shall be immediately brought to the attention of the owner or owner's representative in writing.

1. Starting of work without such notification will be considered acceptance by the Contractor of surfaces involved.

2. The Contractor shall replace unsatisfactory work caused by improper or defective surfaces, as directed by the owner's representative at no additional cost.

1.2 WORK NOT INCLUDED

A. As specified by Owner or Owner's representative.

1.3 QUALITY ASSURANCE

A. Include on label of containers:

1. Manufacturer's name

2. Type of paint

3. Manufacturer's stock number

4. Manufacturer's color name and number

5. Instructions for thinning or reducing, where applicable

B. Workmanship:

1. All work will be performed by experienced skillful craftsmen to assure finished work of first class quality and durability.

2. All paints and coatings shall be mixed and applied strictly in accordance with the manufacturer's printed instructions.

3. All materials shall be applied evenly with proper film thickness and free of runs, sags, skips and other defects. Enamel shall be sanded lightly between coats, dusted and cleaned before recoating.

4. All work shall be done under favorable weather conditions or the work shall be suitably protected from the weather.

5. Dunn-Edwards does not take responsibility for surface preparation or material application.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in new, original and unopened containers bearing Manufacturer's name, trade name and color name and number.

B. Storage of materials:

1. Store only acceptable project materials on site.

2. Store in suitable location.

3. Restrict storage to paint materials and related equipment.

4. Comply with health and fire regulations.

1.5 CONDITIONS

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be stored and applied.

2. Do not paint when there is a threat of rain within 48 hours or when surface or air temperatures are at or below 50 degrees.

3. Comply with current applicable local, state and federal regulations and requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

Basis of Design - Products specified by name number are products of the Dunn-Edwards Corporation, Los Angeles, California and Rust-Oleum Industrial Brands, Vernon Hills, Illinois.

2.2 COLORS

A. See Finish Schedule on Plans and Specification Section 09 06 00 Schedule of Finishes.

2.3 MIXING AND TINTING

A. Deliver paints ready mixed to job site.

B. All paints and coatings shall be mixed and applied strictly in accordance with the manufacturer's printed instructions.

C. Use tinting colors recommended by manufacturer for specific type of finish.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work as included in Article 3.2 "Preparation of Surfaces". Notify the owner or owner's representative in writing of any defects or conditions which will prevent a satisfactory installation.

B. Do not proceed with surface preparation or coating application until conditions are suitable.

C. Commencement of painting implies acceptance of surfaces.

3.2 PREPARATION OF SURFACE

A. Clean all exterior walls and surfaces of loose and scaly paint, rust, mildew, dirt, dust, chalk, efflorescence and other foreign matter by wire brushing, sanding and scraping as required to provide a clean, sound surface for the new paint coatings.

B. Patch, caulk and repair all surfaces and cracks where necessary with suitable patching materials and smooth off to match adjacent surfaces.

C. Degloss all glossy and previously enameled surfaces to provide a roughened surface or "tooth" for good adhesion on subsequent coats.

D. Use industrial blowers to keep air circulating, allowing products to dry.

E. Follow manufacturer’s Technical Data Sheet and MSDS sheet recommendations for proper application.

3.3 PAINTING SCHEDULE

A. Prepare, paint and finish all surfaces specified and agreed upon.

B. Provide paint finishes of even uniform color, free from cloudy or mottled appearance. Properly correct all non-complying work to the satisfaction of owner or owner's representative and the representative of the paint manufacturer.

C. Paint Application Finish Schedule:

EXTERIOR:

FERROUS METAL, STRUCTURAL STEEL

1st Coat:*	CARBOLINE Rust Bond
2nd Coat:*	CARBOLINE Carbothane Semi Gloss 134 MC
3rd Coat:*	CARBOLINE Carbothane Semi Gloss 134 MC

*** NOTE: See Section 3.2 E.**

NON FERROUS METAL

1st Coat:*	CARBOLINE Galoseal WB Primer
2nd Coat:*	CARBOLINE Carbothane Semi Gloss 134 MC

3rd Coat:* CARBOLINE Carbothane Semi Gloss 134 MC

*** NOTE: See Section 3.2 E.**

INTERIOR:

CONCRETE, WALLS

1st Coat:*	CARBOLINE Galoseal WB Primer
2nd Coat:*	CARBOLINE Carboguard 890 VOC
3rd Coat:*	CARBOLINE Carboguard 890 VOC

*** NOTE: See Section 3.2 E.**

FERROUS METAL, BEAMS, TRUSS, COLUMS, RAILINGS, CATWALKS, STAIRS.

1st Coat:*	CARBOLINE Rust Bond
2nd Coat:*	CARBOLINE Carboguard 890 VOC
3rd Coat:*	CARBOLINE Carboguard 890 VOC

*** NOTE: See Section 3.2 E.**

(Continued Interior Section)

NON FERROUS METAL, CORRUGATED METAL DECK, ELECTRICAL CONDUIT, VENTS

1st Coat:*	CARBOLINE Rust Bond
2nd Coat:*	CARBOLINE Carboguard 890 VOC
3rd Coat:*	CARBOLINE Carboguard 890 VOC

*** NOTE: See Section 3.2 E.**

GYPSUM BOARD, OUTER WALLS OF OFFICE, LOCKER ROOMS AND RESTROOM

1st Coat:*	CARBOLINE Rust Bond
2nd Coat:*	CARBOLINE Carboguard 890 VOC
3rd Coat:*	CARBOLINE Carboguard 890 VOC

*** NOTE: See Section 3.2 E.**

GYPSUM BOARD, INTERIOR WALLS OF OFFICE, LOCKER ROOMS AND RESTROOM

1st Coat:*	BLOCK IT Premium Primer BIPR00
2nd Coat:*	ARISTOWALL Interior Semi Gloss AWLL50
3rd Coat:*	ARISTOWALL Interior Semi Gloss AWLL50

*** NOTE: See Section 3.02 E.**

CONCRETE FLOORS

2 Coats: SC9100 Two component Epoxy System by Rust Oleum Corportion

3.4 PROTECTION AND CLEAN UP

A. Protection: Carefully protect areas where work is in progress from damage.

1. Provide and spread clean dropcloths when and where required to provide the necessary protection.

2. Immediately clean-up all accidental spatter, spillage, misplaced paint and restore the affected surface to its original condition.

B. Clean-Up: At completion of work, remove all materials, supplies, debris and rubbish and leave each area in a clean, acceptable condition.

- - - END - - -

SECTION 10 14 00
SIGNAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies interior signage for room numbers, code required signs, and temporary interior signs.

1.2 RELATED WORK

A. Lighted EXIT signs for egress purposes are specified under Division 26, ELECTRICAL.

1.3 MANUFACTURER'S QUALIFICATIONS

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 00, 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 Project Engineer, other returned to Contractor.
   1. Sign Panel, 200 x 250 mm (8 x 10 inches), with letters.
   2. Color samples of each color, 150 x 150 mm (6 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):

B209-07.....................................Aluminum and Aluminum-Alloy Sheet and Plate

B221-06.....................................Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

C. Federal Specifications (Fed Spec):

MIL-PRF-8184F ....Plastic Sheet, Acrylic, Modified

MIL-P-46144C............................Plastic Sheet, Polycarbonate

D. Department of Veterans Affairs:

Architectural Barriers Act ....Accessibility Standards (ABAAS)

PG-18-13..................................VA Barrier Free Design Guide

1.7 MINIMUM SIGN REQUIREMENTS

A. Permanent Rooms and Spaces (per ABAAS and PG-18-13 as applicable):

1. Tactile and Braille Characters, raised minimum 0.793 mm (1/32 inch). Characters shall be accompanied by Grade 2 Braille.
2. Fonts: Characters shall be uppercase, and selected from fonts where the width of the uppercase letter ‘O’ is 55 percent minimum and 110 percent maximum of the height of the uppercase letter ‘I’. Helvetica Medium Condensed and Helvetica Regular are acceptable fonts; Helvetica Medium shall not be acceptable.
3. Character Height: Minimum 16 mm (5/8 inch) high when viewed from a horizontal distance of less than 1830 mm (72 inches); maximum 50 mm (2 inches). Character height shall be based on the uppercase letter ‘I’.
4. Finish and Contrast: Characters and background shall be eggshell, matte or other non-glare finish with adequate contrast with background.
5. 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.

1.8 COLORS AND FINISHES:

Match Existing Medical Center Standards.

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. Project 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.

2.3 SIGN STANDARDS

A. Match existing Medical Center Standards.

2.4 FABRICATION

A. Design components to allow for expansion and contraction for a minimum material temperature range of 38 degrees C (100 degrees 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, arisses unbroken, profiles accurate and ornament true to pattern. Plane surfaces shall 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 su1rfaces.

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 be cleaned and adjusted to operate as designed without binding of 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 Project Engineer and 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 Project 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 Project 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. 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.

G. 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.

H. 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.

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SECTION 10 44 13
FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers surface mounted fire extinguisher cabinets.

1.2 RELATED WORK

A. Acrylic glazing: Section 08 80 00, GLAZING

B. Field 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: Fire extinguisher cabinet including installation instruction and rough opening required.

1.4 APPLICATION 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):

D4802-10 ....Poly (Methyl Methacrylate) Acrylic Plastic Sheet

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHER CABINET

A. Recessed type with flat trim of size and design shown.

2.2 FABRICATION

A. Form body of cabinet from 0.9 mm (0.0359 inch) thick sheet steel.

B. Fabricate door and trim from 1.2 mm (0.0478 inch) thick sheet steel with all face joints fully welded and ground smooth.

1. Glaze doors with 6 mm (1/4 inch) thick ASTM D4802, clear acrylic sheet, Category B-1, Finish 1.
2. Design doors to open 180 degrees.
3. Provide continuous hinge, pull handle, and adjustable roller catch.

2.3 FINISH

A. Finish interior of cabinet body with baked-on semigloss white enamel.

B. Finish door, frame with manufacturer's standard baked-on prime coat suitable for field painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide backing in studwalls and install fire extinguisher cabinets and secure in accordance with manufacturer's instructions.

B. Install cabinet so that bottom of cabinet is 975 mm (39 inches) above finished floor.

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SECTION 13 05 41
SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

PART 1 – GENERAL

1.1 DESCRIPTION:

A. Provide seismic restraint in accordance with the requirements of this section in order to maintain the integrity of nonstructural components of the building so that they remain safe and functional in case of seismic event.

B. Definitions: Non-structural building components are components or systems that are not part of the building's structural system whether inside or outside, above or below grade. Non-structural components of buildings include:

1. Architectural Elements: Facades that are not part of the structural system and its shear resistant elements; 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; 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; 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. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.3 QUALITY CONTROL:

A. Shop-Drawing Preparation:

1. Have 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 where the project is located.

2. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in the State where project is located.

B. Coordination:

1. Do not install seismic restraints until seismic restraint submittals are approved by the Project Engineer.

2. Coordinate and install trapezes or other multi-pipe hanger systems prior to pipe installation.

C. Seismic Certification: In structures assigned to IBC Seismic Design Category C, D, E, or F, permanent equipment and components are to have Special Seismic Certification in accordance with requirements of section 13.2.2 of ASCE 7 except for equipment that is considered rugged as listed in section 2.2 OSHPD code application notice CAN No. 2-1708A.5, and shall comply with section 13.2.6 of ASCE 7.

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.

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 plane.

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.

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 design calculations prepared and sealed by the registered structural engineer specified above in paragraph 1.3A.

E. Submit for concrete anchors, the appropriate ICBC evaluation reports, OSHPD pre-approvals, or lab test reports verifying compliance with OSHPD Interpretation of Regulations 28-6.

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):

355.2-07 .... Qualification for Post-Installed Mechanical Anchors in Concrete and Commentary

C. American Institute of Steel Construction (AISC):

Load and Resistance Factor Design, Volume 1, Second Edition

D. American Society for Testing and Materials (ASTM):

A36/A36M-08 .... Standard Specification for Carbon Structural Steel

A53/A53M-10 .... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A307-10..................................... Standard Specification for Carbon Steel Bolts and Studs; 60,000 PSI Tensile Strength.

A325-10..................................... Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A325M-09.................................. Standard Specification for High-Strength Bolts for Structural Steel Joints [Metric]

A490-10..................................... Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength

A490M-10.................................. Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric]

A500/A500M-10 .... Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

A501-07..................................... Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

A615/A615M-09 .... Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

A992/A992M-06 .... Standard Specification for Steel for Structural Shapes for Use in Building Framing

A996/A996M-09 .... Standard Specification for Rail-Steel and Axel-Steel Deformed Bars for Concrete Reinforcement

E488-96(R2003) .... Standard Test Method for Strength of Anchors in Concrete and Masonry Element

E. American Society of Civil Engineers (ASCE 7), Latest Edition

F. International Building Code (IBC), Latest Edition

G. VA Seismic Design Requirements, H-18-8, February 2011

H. National Uniform Seismic Installation Guidelines (NUSIG)

I. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

Seismic Restraint Manual - Guidelines for Mechanical Systems, 1998 Edition and Addenda

1.6 REGULATORY REQUIREMENT:

A. IBC 2012

B. 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 ½ inches inside diameter
5. All other piping less than 2 ½ 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 ½ 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.

PART 2 – PRODUCTS

2.1 STEEL:

A. Structural Steel: ASTM A36

B. Structural Tubing: ASTM A500, Grade B

C. Structural Tubing: ASTM A501

D. Steel Pipe: ASTM A53/A53M, Grade B

E. Bolts & Nuts: ASTM A307

2.2 CAST-IN-PLACE CONCRETE:

A. Concrete: 28 day strength, f’c = 25 MPa (3,000 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 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 masonry and 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.

3.2 EQUIPMENT RESTRAINT AND BRACING:

A. See drawings for equipment to be restrained or braced.

3.3 MECHANICAL DUCTWORK AND 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 to resist directional forces (lateral, longitudinal and vertical).

B. Brace duct and breeching branches with a minimum of 1 brace per branch.

D. 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.

E. Seismic Restraint of Piping:

1. Design criteria:

a. Piping resiliently supported: Restrain to support 120 percent of the weight of the systems and components and contents.

b. Piping not resiliently supported: Restrain to support 60 percent of the weight of the system components and contents.

F. 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.

B. Properly anchor masonry walls to the structure for restraint, so as to carry lateral loads imposed due to earthquake along with their own weight and other lateral forces.

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.

B. Independently support and laterally brace all lighting fixtures. Refer to applicable portion of lighting specification, Section 26 51 00, INTERIOR LIGHTING.

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SECTION 23 05 10
COMMON WORK RESULTS FOR BOILER 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 boiler plant and 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. PE: Project Engineer

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.

D. Section 05 50 00, METAL FABRICATIONS.

E. Section 07 84 00, FIRESTOPPING.

F. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.

G. Section 07 92 00, JOINT SEALANTS.

H. Section 09 91 00, PAINTING.

I. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

J. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.

K. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

L. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

M. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

N. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

O. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

P. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

Q. Section 23 10 00, FACILITY FUEL SYSTEMS.

R. Section 23 11 23, FACILITY NATURAL-GAS PIPING.

S. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

T. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

U. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.

V. Section 23 52 33, WATER-TUBE BOILERS.

W. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

X. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

Y. Section 26 29 11, LOW-VOLTAGE 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. Equipment Vibration Tolerance:

1. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.

C. 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. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for quality assurance requirements for boiler plant computer workstation software.
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. 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 then those specified. Refer any conflicts to the Project Engineer (RE).
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.

D. 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.

E. 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.

F. Boiler Plant and Outside Steam Distribution Welding: Refer to Sections 23 21 11, BOILER PLANT PIPING SYSTEMS, and 33 63 00, STEAM ENERGY DISTRIBUTION.

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 Project Engineer for resolution. Provide written hard copies or computer files of manufacturer’s installation instructions to the Project 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 Project 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.

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.

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 boiler plant work are defined in the following checklist:

1. Group II (Burner Fuel Oil Systems):
    a. Fuel oil pumping system.
    b. Pressure control and relief valves.
2. Group III: Boilers, burners including forced draft fan and motor controls, boiler accessories (trim), fuel valve trains, atomizing media valve trains, economizers and accessories (when provided), stacks and breeching.
3. Group IV (Boiler/Burner Controls and Boiler Plant Controls and Instrumentation): Boiler control system, 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.
4. Group V (Condensate Storage):
    a. Condensate storage tank and accessories.
    b. Concrete foundation and anchorage.
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.

e. Water level control valve at boilers as approved in Group III.

6. Group VII (Temporary Boiler Plant Equipment):

a. Boilers.

b. Burners.

c. Controls.

d. Instruments.

e. Deaerator.

f. Blow down separator.

g. Other Equipment.

G. Ungrouped submittal items for boiler plants, 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 - boilers.
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. Quick-couple hose fittings and steam hose.
20. Heating and ventilating equipment.
21. Condensate pump sets.
22. Compressed air system.
23. Vibration isolators - air, water, oil.
24. Supports and braces for pipe, stacks, breeching; load, size, movement calculations.
25. Pressure gauge test kit.
26. Insulation, field-applied.

27. Boiler plant building dangerous gas detection system.
28. Seismic calculations and drawings indicating equipment and piping anchoring, reinforcement and bracing.
29. Earthquake valves - gas.

H. Layout Drawings:

1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas.
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.

I. 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 Project 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. For boiler plants, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, for additional requirements.
6. Wall, floor, and ceiling plates.

J. 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.

K. Boiler Plant Maintenance Data and Operating Instructions:

1. Provide four bound copies. Deliver to Project Engineer not less than 30 days prior to completion of a phase or final inspection.
2. Include all new and temporary 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 boiler firing and 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.

L. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

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 (AHRI):

430-2009 .... Central Station Air-Handling Units

C. American National Standard Institute (ANSI):

B31.1-2007................................. Power Piping

D. Rubber Manufacturers Association (ANSI/RMA):

IP-20-2007 .... Specifications for Drives Using Classical V-Belts and Sheaves
IP-21-2009 .... Specifications for Drives Using Double-V (Hexagonal) Belts
IP-22-2007 .... Specifications for Drives Using Narrow V-Belts and Sheaves

E. Air Movement and Control Association (AMCA):

410-96 ....Recommended Safety Practices for Air Moving Devices

F. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code (BPVC):

Section I-2007............................Power Boilers

Section IX-2007..........................Welding and Brazing Qualifications

Code for Pressure Piping:

B31.1-2007.................................Power Piping

G. American Society for Testing and Materials (ASTM):

A36/A36M-08 ....Standard Specification for Carbon Structural Steel

A575-96(2007) ....Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

E84-10..Standard Test Method for Surface Burning Characteristics of Building Materials

E119-09c....................................Standard Test Methods for Fire Tests of Building Construction and Materials

H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:

SP-58-2009 ....Pipe Hangers and Supports-Materials, Design and Manufacture, Selection, Application, and Installation

SP 69-2003 ....Pipe Hangers and Supports-Selection and Application

SP 127-2001 ....Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application

I. National Electrical Manufacturers Association (NEMA):

MG-1-2009 ....Motors and Generators

J. National Fire Protection Association (NFPA):

31-06 ....Standard for Installation of Oil-Burning Equipment

54-09 ....National Fuel Gas Code

70-08 ....National Electrical Code

85-07 ....Boiler and Combustion Systems Hazards Code

90A-09..Standard for the Installation of Air Conditioning and Ventilating Systems

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 Project 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 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 Project 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 Project 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

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

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, LOW-VOLTAGE 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, LOW-VOLTAGE 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. Unit shall be rated for minimum 30,000 AIC. Provide AC input line reactors (3% impedance) on incoming power line. Provide output line reactors on line between drive and motor where the distance between the breaker and motor exceeds 50 feet.

2.8 BOILER PLANT CONTROLS AND INSTRUMENTATION, COMPUTER WORKSTATION

A. Provide, and place into proper operation, complete systems as specified in Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT; and Section 23 09 11, INSTRUMENTATION AND

CONTROL FOR BOILER PLANT. Furnish all hardware, software and programming to properly accomplish specified functions.

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 TEMPORARY BOILER PLANT INSTALLATION

A. Provide temporary facilities to replace all functions of the existing boiler plant during the construction period. Temporary facilities must remain in operation until all new facilities are accepted for beneficial use. Temporary facilities shall provide same quality of service as existing facilities.

B. Refer to drawings for arrangement and location of temporary facilities and for equipment performance requirements.

C. Temporary equipment may be new or previously used. Previously used equipment shall show no evidence of wear or deterioration that would effect the safe, reliable operation.

D. Equipment to be utilized in the new plant shall not be used in the temporary plant, except with permission of the Project Engineer.

E. Remove all temporary facilities from Government property after final use.

F. Equipment must be clean inside and outside.

G. Feedwater System:

1. Provide system, including feedwater deaerator, to furnish minimum water temperature of 104 degrees C (220 degrees F), pressure and quality recommended by boiler manufacturer. Maximum oxygen content of feedwater from deaerator twelve parts per billion (12 ppb).
2. Capacity shall exceed maximum steam flow requirement of Medical Center.
3. Provide automatic feedwater deaerator water level control and high and low level alarms.
4. Provide one full size redundant feed pump.
5. Automatic boiler water level control with three-valve bypass.
6. Automatic water softener for make-up water. (Use facility soft water).
7. Prior to operation, provide internal inspection of feedwater deaerator by Authorized Inspector certified by the National Board of Boiler and Pressure Vessel Inspectors. Submit signed report. Inspector must certify deaerator as clean and safe for operation.

H. Instrumentation:

1. Record steam flow rate and provide totalizer for each boiler.
2. Pressure gage for main steam, feedwater header, fuel oil and natural gas headers.
3. Mount recorders and pressure gages in painted, reinforced sheet metal panel.
4. Provide 100 recorder charts of each type and two replacement recorder pens for each pen arm.

I. Chemical Treatment System: Provide individual pump type systems to deliver proper chemicals to each boiler. Water quality shall be maintained as directed by contractor-retained water treatment firm. All chemicals must be FDA approved for use where steam contacts food. Provide chemical treatment, or maintain existing chemical treatment, which protects all site condensate lines from corrosion.

J. Blowoff System: Provide system to collect boiler bottom blowoff and to discharge it to sanitary sewer at temperature not exceeding 65 degrees C (150 degrees F).

K. Fuel System: Provide systems to furnish sufficient No. 2 fuel oil to generate steam to satisfy maximum steam flow demand of Medical Center. Comply with NFPA 31 and 54. Provide filtration systems to protect pumps, flow meters, and pressure control valves. Fuel oil systems shall operate with no air entrainment or pump cavitation.

L. Access Platforms and Ladders: Provide for access to all valves, controls and instruments not accessible to personnel standing on floor. Design of platforms and ladders must comply with OSHA requirements.

M. Enclosure of Temporary Equipment: Provide clean, dry, ventilated, lighted, heated shelter for all equipment and for operating personnel. Heating system shall maintain 18 degrees C (65 degrees F) under all weather conditions and when boilers are not in operation. Shelter construction must comply with all state and local codes.

N. Pipe, Stack, and Breeching Supports: Support all hot systems on roller and spring hangers. Anchor and support all systems in compliance with recommendations and requirements of ASME B31.1, and MSS-SP69.

O. Power Supply: Provide full time power and emergency power to serve full load operation of all equipment in temporary boiler plant.

P. Repairs and Maintenance: Contractor shall furnish labor and material for all repairs at no cost to the Government. Malfunctions that reduce the steam supply to the facility shall be repaired within four hours of notice. Other repairs shall be accomplished within 24 hours of notice. Routine maintenance requiring standard tools and supplies and less than one man-hour per day will be performed by the Government. Cleaning made necessary by Government operation will be performed by the Government.

Q. Seismic Anchorage of Equipment and Bracing of Piping, Stacks, Breeching: Conform to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.10 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. Boiler 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.

2.11 FIRESTOPPING

Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.12 GALVANIZED REPAIR COMPOUND

Mil. Spec. DOD-P-21035B, paint form.

2.13 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. Pipe Hangers and Supports for Boiler Plant: Refer to Section 23 21 11, BOILER 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 Project Engineer for each job condition.
3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Project Engineer for each job condition.

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 31 00, STEEL DECKING. 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, PLUMBING, AND BOILER 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.

2.14 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 Project 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.

2.15 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.

B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

2.16 SPECIAL TOOLS AND LUBRICANTS

A. Furnish, and turn over to the Project 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 in tended service and mounted, or located, where directed by the Project 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.

2.17 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.

2.18 ASBESTOS

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 Project 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 Project Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Project 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 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 Project Engineer. Damaged or defective items in the opinion of the Project 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 Project 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 Project 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.
9. Temporary Facilities: Refer to Article, TEMPORARY PIPING AND EQUIPMENT in this section.
10. 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 Project Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Project Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Project Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

P. 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).

Q. 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 Project 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 Project 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 Project 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 Project 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.

E. Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

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. Boiler 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 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 BOILER PLANT

E. 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 Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.11 STARTUP AND TEMPORARY OPERATION

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, Article, TESTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT, and submit the test reports and records to the Project 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 DEMONSTRATIONS AND TESTS, TEMPORARY BOILER PLANT EQUIPMENT

A. Test prior to placing in service.

B. Demonstrate to Project Engineer the proper operation of all equipment, instruments, operating and safety controls, and devices.

C. Demonstrate to Project 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.

3.14 INSTRUCTIONS TO VA PERSONNEL

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

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SECTION 23 05 12
GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.

1.2 RELATED WORK:

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.
B. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.
C. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
D. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

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 Project 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

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):

MG 1-2006 Rev. 1 2009 ....Motors and Generators

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):

70-2008 ....National Electrical Code (NEC)

D. Institute of Electrical and Electronics Engineers (IEEE):

112-04 ....Standard Test Procedure for Polyphase Induction Motors and Generators

E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

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, LOW-VOLTAGE 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 systems: 230/ 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 systems: 208-230/ volts, dual connection.
      c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
      d. 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:

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 Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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SECTION 23 05 41
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

Noise criteria, seismic restraints for equipment, vibration tolerance and vibration isolation for HVAC and plumbing work.

1.2 RELATED WORK

A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete inertia bases.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment

C. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 QUALITY ASSURANCE

A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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
Bathrooms and Toilet Rooms	40
Locker Rooms	45
Offices, Small Private	35
Shops	50

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 a horizontal force of 101 percent of the weight of the equipment and 27 percent of the equipment weight for vertical seismic force.

   b. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force of 202 percent of the weight of the equipment for the floor mounted equipment and 303 percent for the roof mounted equipment. Both shall be sized for vertical seismic force of 27 percent of equipment weight.

2. Piping: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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.

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):

2009 .... Fundamentals Handbook, Chapter 7, Sound and Vibration

C. American Society for Testing and Materials (ASTM):

A123/A123M-09 .... Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A307-07b................................... Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

D2240-05(2010) .... Standard Test Method for Rubber Property - Durometer Hardness

D. Manufacturers Standardization (MSS):

SP-58-2009 .... Pipe Hangers and Supports-Materials, Design and Manufacture

E. Occupational Safety and Health Administration (OSHA):

29 CFR 1910.95......................... Occupational Noise Exposure

F. American Society of Civil Engineers (ASCE):

ASCE 7-10 .... Minimum Design Loads for Buildings and Other Structures.

G. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's National Association (ANSI/SMACNA):

001-2008 .... Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition.

H. International Code Council (ICC):

2009 IBC .... International Building Code.

I. Department of Veterans Affairs (VA):

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. Elastometric 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 75 mph shall be employed.

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 EQUIPMENTS

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.
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 ¼’ 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.

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 (l00 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
PUMPS																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	2 HP & OVER	---	---	---	I	S	0.8	I	S	1.5	I	S	1.5	I	S	2.0
LARGE INLINE	Up to 25 HP	---	---	---	---	S	0.75	---	S	1.50	---	S	1.50	---	---	NA
	26 HP THRU 30 HP	---	---	---	---	S	1.0	---	S	1.50	---	S	2.50	---	---	NA
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	15 HP THRU 40 HP	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.0	I	S	2.0
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.5	I	S	2.5
ROOF FANS																

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
ABOVE OCCUPIED AREAS:															
5 HP & OVER	---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
CENTRIFUGAL FANS															
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM	B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5
60 HP & OVER:															
UP TO 300 RPM	B	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301 - 500 RPM	B	S	2.0	I	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM & OVER	B	S	1.0	I	S	2.0	I	S	2.0	I	S	2.5	I	S	2.5
INTERNAL COMBUSTION ENGINES															
UP TO 25 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
30 THRU 100 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
125 HP & OVER	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
HEAT PUMPS															

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
ALL	---	S	0.75	---	S	0.75	---	S	0.75	CB	S	1.5	---	---	NA
CONDENSING UNITS															
ALL	---	SS	0.25	---	SS	0.75	---	SS	1.5	CB	SS	1.5	---	---	NA

NOTES:

1. Edit the Table above to suit where isolator, other than those shown, are used, such as for seismic restraints and position limit stops.
2. For suspended floors lighter than 100 mm (4 inch) thick concrete, select deflection requirements from next higher span.
3. For separate chiller building on grade, pump isolators may be omitted.
4. Direct bolt fire pumps to concrete base. Provide pads (D) for domestic water booster pump package.
5. For projects in seismic areas, use only SS & DS type isolators and snubbers.
6. For floor mounted in-line centrifugal blowers (ARR 1): use "B" type in lieu of "R" type base.
7. Suspended: Use "H" isolators of same deflection as floor mounted.

SECTION 23 05 51
NOISE AND VIBRATION CONTROL FOR BOILER PLANT

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the application of noise and vibration control techniques to boiler plant rotating equipment including pumps, fans, compressors, motors and steam turbines.

1.2 RELATED WORK

A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION

B. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Vibration isolators

C. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT

D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

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.

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):

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

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. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT. Tests shall be conducted by an experienced technician in the presence of the Project 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-l00 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

SECTION 23 07 11
HVAC AND BOILER 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.
2. Re-insulation of HVAC piping, ductwork and equipment, plumbing piping and equipment and boiler plant piping, breeching and stacks 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, 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, and pipe spaces.
5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler 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, 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); Boiler Plant 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^3 - 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. HWH: Hot water heating supply.
21. HWHR: Hot water heating return.
22. FWPD: Feedwater pump discharge.
23. FWPS: Feedwater pump suction.
24. CTPD: Condensate transfer pump discharge.
25. CTPS: Condensate transfer pump suction.
26. VR: Vacuum condensate return.
27. CPD: Condensate pump discharge.
28. R: Pump recirculation.
29. FOS: Fuel oil supply.
30. FOR: Fuel oil return.
31. CW: Cold water.
32. SW: Soft water.
33. HW: Hot water.
34. CH: Chilled water supply.
35. CHR: Chilled water return.
36. GC: Chilled glycol-water supply.
37. GCR: Chilled glycol-water return.
38. RS: Refrigerant suction.
39. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

A. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT: Insulation containing asbestos material.
B. Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT: Insulation containing asbestos material.
C. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
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 BOILER 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, BOILER PLANT PIPING SYSTEMS: Boiler plant piping.

H. Section 23 21 23, HYDRONIC PUMPS

I. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING

J. Section 23 22 23, STEAM CONDENSATE PUMPS

K. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT

L. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS

M. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant piping and fittings.

N. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and equipment.

O. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.

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 BOILER 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.
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. 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

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.):

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.):

MIL-A-3316C (2)-90 ....Adhesives, Fire-Resistant, Thermal Insulation

MIL-A-24179A (1)-87 ....Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)-88.................Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier

MIL-C-20079H-87 ....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

D. American Society for Testing and Materials (ASTM):

A167-99(2004) ....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-07......................................Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C411-05 ....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation

C449-07 ....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

C533-09 ....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

C534-08 ....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

C547-07 ....Standard Specification for Mineral Fiber pipe Insulation

C552-07 ....Standard Specification for Cellular Glass Thermal Insulation

C553-08 ....Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

C585-09 ....Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)

C612-10 ....Standard Specification for Mineral Fiber Block and Board Thermal Insulation

C1126-04 ....Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation

C1136-10 ....Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

D1668-97a (2006).......................Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing

E84-10...Standard Test Method for Surface Burning Characteristics of Building
Materials

E119-09c.....................................Standard Test Method for Fire Tests of Building Construction and Materials

E136-09b.....................................Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)

E. National Fire Protection Association (NFPA):

90A-09 ....Standard for the Installation of Air Conditioning and Ventilating Systems

96-08 ....Standard~~s~~ for Ventilation Control and Fire Protection of Commercial Cooking Operations

101-09 ....Life Safety Code

251-06 ....Standard methods of Tests of Fire Endurance of Building Construction Materials

255-06 ....Standard Method of tests of Surface Burning Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

723 ....UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 09/08

G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):

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^3 (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-5, Density 32 kg/m^3 (2 pcf), k = 0.04 (0.27) 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^3 (7.5 pcf) nominal, k = 0.033 (0.29) at 24~~0~~ 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 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

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.

2.6 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:

Insulation Characteristics		
ITEMS	**TYPE I**	**TYPE II**
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m^3 (lb/ ft3)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft^2 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

2.7 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 exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.)in high humidity areas. 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.

2.8 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.

2.9 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 or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

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 high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

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.

2.10 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.

2.11 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 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.

2.12 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.

2.13 FIRESTOPPING MATERIAL

Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.14 FLAME AND SMOKE

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 Project 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. Where removal of insulation of piping, ductwork and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification.

D. 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).

E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

F. 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.

G. 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.

H. 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.

I. HVAC work not to be insulated:

1. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
2. In hot piping: Unions, flexible connectors, control valves, 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. Boiler plant work not to be insulated:

1. Pipes, valves and fittings:
   a. Gas fuel
   b. Oil unheated
   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. Pressure transmission to gages
p. Piping in control panels
q. Tube cleaning piping
r. Chemical feed from pump-type feeders
s. Condensate piping from flash tank to condensate return pump

2. Boilers:
   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. Soot blower and piping
   f. Safety valves and drip pan ells
   g. Water level sensors and piping except where required by equipment manufacturer
   h. Control piping and devices or interlocks
   i. Drum heads (watertube boilers)
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. Oil meters
   h. Chemical feeders
   i. Boiler and feedwater sampler
   j. All nameplates
4. Specialties:
   a. Pressure reducing valves
   b. Control valves-water and steam
   c. Level sensors-piping, valves and blowdown
   d. Back pressure regulators-oil and steam
   e. Strainers under 65 mm (2-1/2 inch) pipe size
   f. Expansion bellows
   g. Flexible connectors
   h. 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. Firestop Pipe and Duct insulation:

1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    a. Pipe risers through floors
    b. Pipe or duct chase walls and floors
    c. Smoke partitions
    d. Fire partitions

N. Provide vapor barrier jackets over insulation as follows:

1. All piping and ductwork exposed to outdoor weather.

O. Provide metal jackets over insulation as follows:

1. All piping and ducts exposed to outdoor weather.
2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

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.

3. 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).
    d. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.

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.

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. 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.

E. 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 3.7 for Boiler Plant Applications.

3.3 APPLICATION –BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:

A. 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, boiler bottom blowoff from boiler to blowoff valve closest to boiler.
2. Insulation and Jacket:
   a. Calcium silicate for piping from zero to 1800 mm (6 feet) above boiler 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 boilers and burners.
3. Thickness:

Nominal Thickness Of Calcium Silicate Insulation (Boiler 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)

B. 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, boiler feedwater from feedwater heater to boiler feed pump recirculation, feedwater heater overflow, heated oil from oil heater to burners.
2. Insulation and Jacket:
   a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above boiler 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 boilers and burners.

3. Thickness-calcium silicate 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)

C. Temperature range 32 to 99 degrees C (90 to 211 degrees F):

1. Application: Pumped condensate, vacuum heating return, gravity and pumped heating returns, condensate transfer, condensate transfer pump recirculation, heated oil system to heaters and returns from burners, condensate return from convertors and heated water storage tanks.

2. Insulation Jacket:

a. Calcium silicate for piping from zero to 1800 mm (six feet above boiler 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)

D. 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 boiler water sample, blowoff tank vent, flash tank vents and condensater tank vent, shot-type chemical feed, fire tube boiler bottom blowoff after valves, valve by-passes.
   2. Insulation thickness: 25 mm (1 inch).
   3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at boilers within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.
E. 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-BOILER FLUE GAS SYSTEMS

A. Temperature range 150 to 370 degrees C (300 to 700 degrees F):
1. Application: Transitions, stacks and breechings from boiler outlet to stack outlet; induced draft fans (if provided); flue gas recirculation fans and ductwork (if provided).
2. Thickness:
   a. Single-wall duct systems: 50 mm (2 inches).
   b. Double-wall factory-fabricated duct systems with air space between walls: None.
3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.

B. Protective Insulation to Prevent Personnel Injury:
1. Application: Double wall factory-fabricated duct system with uninsulated air space between walls within 900 mm (3 feet) horizontally and 1800 mm (6 feet) vertically of platform or floor.
2. Insulation thickness; 25 mm (1 inch).
3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.

C. 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 APPLICATION-BOILER DEAERATING FEEDWATER HEATER, TANKS

A. Temperature range 38 to 120 degrees C (100 to 250 degrees F)
1. Application: Deaerating feedwater heater and storage tank, condensate storage tanks, heat exchangers, blowoff tank.
2. Insulation Thickness:
   a. Feedwater heater and storage tanks: 75 mm (3 inches)
   b. Condensate storage tanks: 50 mm (2 inches)
   c. Blowoff tank, heat exchangers: 25 mm (1 inch).

3. Insulation and covering: Calcium silicate with glass cloth jacket.

B. Insulating:

1. Insulate tanks with an assembly of chamfered block to fit curvature. Secure with 1.6 mm diameter (16 gage) wire or stainless steel bands 300 mm (12 inches) on centers, fill all voids and interstices with finishing cement coat, imbed hexagonal wire mesh in first finish coat. Provide a second finish coat and a glass cloth covering.
2. Apply glass cloth with adhesive, smooth, tight and neatly finished at all cloth edges; prime to receive paint.
3. Do not insulate over nameplates and data plates. Nameplates and data plates must be legible.

3.6 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.7 PIPE INSULATION SCHEDULE

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
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	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)

Valves, Condensate receivers and flash tanks)					
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, HWH, HWHR, GH and GHR)	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, HWH, HWHR, GH and GHR)	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, HWH, HWHR, GH and GHR)	Polyiso-cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	----	----
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----

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SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the Boiler systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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 Contract Documents developed with the approval of the VA.

   1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
   2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.
   3. Activities and documentation for the LEED™ section on “Measurement and Verification” requirements for the Measurement and Verification credit.

D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division 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 HVAC systems will be commissioned:

1. Boiler system, SCR, economizer, piping.
2. AC units
3. Exhaust Fans (Fan, motor, controls and safeties).
4. Steam System (<u>Controls</u> gages and instrumentation, safety relief valves.)
5. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Project Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.4 TRAINING OF VA PERSONNEL

A. Training of the VA's operation and maintenance personnel is required in cooperation with the Project Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Project Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

----- END -----

SECTION 23 08 11
DEMONSTRATIONS AND TESTS FOR BOILER PLANT

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Procedures for on-site demonstration and testing of equipment and systems, including temporary facilities.

B. Instruction of Government operating personnel.

C. All demonstrations, instructions and testing must be completed prior to Government acceptance for beneficial use.

D. Plumbing and emergency power systems are not included.

1.2 DEFINITIONS

A. Start-Up: Initial inspection, cleaning, lubrication, adjustment, and operation of equipment and systems by the contractor with the assistance of the representatives of the equipment manufacturers.

B. Pre-Tests: The final stage of the start-up procedure. This occurs after all adjustments have been made except for minor fine-tuning that can be done during the pre-test. Serves as verification that the systems are ready for the final test. Witnessing of pre-test by Project Engineer (RE) is not required.

C. Final Tests: Tests, witnessed by the RE/COTR or their representative, which demonstrate that all equipment and systems are in compliance with requirements. At VA expense, VA may utilize the services of an independent testing organization or consultant to witness the tests.

1.3 RELATED REQUIREMENTS

A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION: Operating and maintenance manuals

B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION: Demonstration, instructions and testing of temporary equipment

C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT: Sound and vibration levels; sound tests and vibration testing of rotating equipment

D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Leak testing of piping systems, pressure testing of non-boiler safety valves

E. Section 23 10 00, FACILITY FUEL SYSTEMS: Leak testing of oil tanks and underground oil piping systems

F. Section 23 52 39, FIRE-TUBE BOILERS: Demonstration and testing of fire tube boilers, burners, controls and accessories

G. Section 23 52 33, WATER-TUBE BOILERS: Demonstration and testing of water tube boilers, burners, controls and accessories

H. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT: Demonstration and testing of feedwater deaerator

I. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Demonstration and testing of boiler plant instrumentation, controls and computer work station

J. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training

1.4 QUALITY ASSURANCE

A. Experienced, trained technical service personnel who are representatives of the equipment manufacturers and system designers shall demonstrate, provide instructions, pre-test and final test, as specified, the following equipment:

1. Boilers and economizers
2. Burners
3. Control systems.
4. Instrumentation.
5. Deaerating feedwater heater

B. Experienced technicians shall demonstrate and provide instructions on the following equipment:

1. Pumps and piping systems
2. Ventilation and heating systems
3. Compressed air systems
4. Control and safety valves

C. The person responsible for programming the computer workstation shall demonstrate and provide instructions on hardware, software and programming.

D. The RE, upon request, will provide a list of personnel to receive instructions and will coordinate their attendance at agreed-upon times.

E. All safety devices shall comply with the VHA Boiler Plant Safety Manual.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Names and qualifications of personnel performing demonstrations, instructions and tests.

C. Certification that pre-testing is complete. Copies of boiler-burner and feedwater deaerator pre-test data as specified.

D. Preliminary schedule of all demonstrations, instructions and final tests two weeks prior to proposed dates.

E. Provide reports within three weeks after satisfactory completion of demonstrations, instructions, and tests. List date, type of work, persons participating, amount of time, test results, calculations of test results, test data.

F. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS

A. Verify that equipment and systems are fully operational. Complete all start-up and pre-test activities for all equipment and systems. Complete all construction and finish work.

B. Arrange for all test personnel for all equipment to be continuously present during one period of time so that all equipment and systems can be tested in their interrelated functions. For instance, feedwater deaerator will be tested during the boiler testing, and instrumentation performance will be evaluated in conjunction with boiler testing.

C. Deliver maintenance and operating manuals four weeks prior to instruction period.

D. Furnish all special tools.

3.2 FINAL TESTS

A. Demonstrate proper operation of each equipment and system.

B. Provide tests on equipment as specified in the individual specification sections.

3.3 STARTUP AND TESTING

A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contactor testing schedules with the Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.5 DEMONSTRATIONS AND TRAINING

A. Demonstrate operation and maintenance of equipment and systems to Government personnel no more than four weeks prior to scheduled Government operation of the plant.

B. Use operation and maintenance manuals as basis of instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance.

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut-down of each item of equipment. Allow Government personnel to practice operating the equipment under supervision of instructors.

D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

E. Provide video with audio of all instructions given orally to VA personnel. Provide four copies of the tapes.

F. Provide services of manufacturer’s technical representative for four hours to instruct VA personnel in operation and maintenance of units.

G. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

3.6 TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS

A. At least 8 total instructor hours to include boilers, economizers, burners, burner controls, combustion controls, instrumentation.

B. At least 8 total instructor hours to include computer workstation and programs.

C. At least 4 total instructor hours to include pumps, steam turbine, feedwater deaerator, and other equipment.

D. If project includes a temporary boiler plant, provide 8 total instructor hours on the temporary equipment.

E. Do not exceed three trainees per session, one-four hour session, per day, per trainee.

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SECTION 23 09 11
INSTRUMENTATION AND CONTROL FOR BOILER PLANT

PART 1 – GENERAL:

1.1 DESCRIPTION:

Automatic controls, instruments, monitoring and data management systems and accessories for the boilers, burners and other boiler plant mechanical equipment. The specification classifies the systems into automatic boiler and burner control systems, burner management systems (flame safeguard), and data management and instrumentation systems.

1.2 RELATED WORK:

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATIONB. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

B. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Piping for controls and instrumentation panel.

C. Section 23 52 39, FIRE-TUBE BOILERS: Feedwater controls and instrumentation furnished with fire tube boilers.

D. Section 23 52 33, WATER-TUBE BOILERS: Instrumentation furnished with water tube boilers.

E. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT: Air compressors and accessories for pneumatic control.

F. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT Automatic controls for water level in the feedwater deaerator storage tank and the condensate storage tank.

G. Section 23 10 00, FACILITY FUEL SYSTEMS: Tank level monitors and leak detection systems for oil tanks and underground oil piping systems (diesel fuel, burner fuel).

H. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

J. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Requirements for commissioning, systems readiness checklists, and training

1.3 QUALITY ASSURANCE:

A. The boiler and burner control, monitoring, data gathering, instrumentation and associated systems specified in this section shall be provided by one company that has been in business at least three years engineering, designing and servicing industrial and institutional boiler control and instrumentation systems similar to those specified herein, as a primary business. That company shall furnish all components and provide complete calibration, programming, start-up, testing, demonstrations, instructions and training services.

B. Submit documented evidence, including start-up and acceptance test data, and references, that the company has performed satisfactory work on at least six systems similar to those specified. For instance, submit experience information on systems involving parallel positioning combustion control and on variable speed forced draft fan drives, if these systems are specified.

C. If new burners are part of the contract, the burner manufacturer shall be responsible for the burner management system (flame safeguard), including interlocks, all accessories and for coordination with other control and monitoring systems.

D. Equipment Experience Requirements: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Code Approval:

1. All burner management and combustion control systems and devices shall comply with NFPA 85. Locations and arrangements of safety devices on fuel trains shall comply with diagrams included in “Annex A” in the code.
2. All burner management controls and interlock devices shall be UL listed and FM approved. All controllers that include burner management functions shall be UL listed and FM approved.
3. Parallel positioning combustion control systems shall comply with UL 1998.
4. Computer-based electronic equipment shall conform to the requirements of FCC Part 15, Subpart J, for Class A computing devices governing radio frequency electromagnetic interference (EMI) while continuing to operate normally.
5. All electrical wiring shall be in accordance with NFPA 70.

F. Personnel: All work shall be done by properly trained, skilled technicians who are regularly employed and qualified in the installation, programming, start-up, calibration, and testing of the systems provided, and who will be directed by experienced engineers employed by the equipment supplier. Personnel must have three years minimum experience with industrial and institutional boiler plant controls and instruments similar to those being furnished for this project.

1.4 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Certificates of compliance with Article, QUALITY ASSURANCE (Articles 1.3.A, B, D & F). In addition, submit past performance questionnaire (Form VA-NEBC) for five (5) past projects of the same class (scope & complexity) as this project.

C. Submit information sufficient to verify compliance with all contract requirements as specified and shown on project drawings.

D. Automatic Boiler Control and Burner Management and Safety Interlock Systems:

1. Catalog cuts and specification sheets providing description and performance data on: Controllers, control and indicating stations, sensors and transmitters, signal conditioners, electric switches and relays, indicators and annunciators, safety interlock devices, drive units and actuators, control valves, mechanical linkage systems, compressed air filters and regulators.

2. Statement from controller manufacturer that the type and model submitted is the current generation and that the manufacturer will support the units with parts and service for at least ten years.
3. Information on all the specific systems that is sufficient to allow complete troubleshooting. As a minimum this should include explanation of the control logic, and wiring diagrams of equipment and systems.
4. Hardware systems schematics showing field and panel equipment interface block diagram.
5. Location of interlock devices on the burners, boilers, fuel trains and accessory equipment.

E. Boiler Plant Instrumentation:
1. Catalog cuts and specification sheets providing description and performance data on instruments and accessories.
2. Installation and troubleshooting instructions for all equipment in bound sets shipped with equipment.
3. List of ranges of recorder displays or charts. For paper chart recorders, submit ranges for charts that will be furnished.
4. Flow meter primary element design, size, performance, and sizing calculation. Steam flow performance data for flow meters verifying project performance requirements.
5. Complete wiring and piping diagrams for all equipment and systems.
6. Wiring and piping materials.

F. Instrumentation and Control Panels:
1. Drawing showing arrangement of instruments and controls on panels.
2. Drawing showing panel arrangements, construction, door swing clearance allowance, dimensions, finishes.
3. Description of panel construction.
4. Seismic restraint design data for freestanding instrument or control panels. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

G. Computer Workstation and Programming:
1. Catalog data with pictures, description, and performance data on all hardware.
2. Hardware specifications.
3. Software model number and supplier. Include complete documentation on all software with shipment.
4. Confirmation that graphics to be provided complies with the specification.
5. Description of computer furniture.

H. As-built Logic and Wiring Diagrams: One set of reproducible prints and CAD disks delivered to Project Engineer (RE) prior to turning systems over to VA for operation. Supply revised drawings if changes are made during the startup and commissioning process.

I. Fluid Flow Meters:
   1. Catalog cuts and drawings with description, specifications and dimensions of meters and accessories.
   2. Design and construction of meters and accessories.
   3. Performance data including flow, pressure drop, accuracy over the metering range of the actual fluids to be metered.
   4. Pressure and temperature limitations.
   5. Manufacturer's installation instructions.
   6. Arrangement of register face and remote indicator (if provided).

J. Pressure Gages and Thermometers:
   1. Catalog cuts showing design, construction, dimensions of gages and accessories.
   2. Accuracy.
   3. Pressure and temperature limitations of gages and accessories.
   4. List of scale ranges to be provided.

K. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

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 (ANSI):

INCITS 154-1988(R1999) .... Office Machines and Supplies - Alphanumeric Machines - Keyboard Arrangements

C. American Society of Mechanical Engineers (ASME):

B16.36-2009.............................. Orifice Flanges
B31.1-2007................................ Power Piping
B40.100-2005............................ Pressure Gauges and Gauge Attachments
PTC 4-2008............................... Fired Steam Generators

D. National Fire Protection Association (NFPA):

70-2011 .... National Electrical Code
85-2007 .... Boiler and Combustion Systems Hazards Code

E. National Electrical Manufacturers Association (NEMA):

ICS 6-93(R2001, R2006) .... Industrial Control and Systems Enclosures
WC 63.2-1996(R2003)............... Performance Standard for Coaxial Premise Data Communications Cables

F. Underwriters Laboratories Inc. (UL):

508-06 .... Industrial Control Equipment

1449-09 .... Transient Voltage Surge Suppressors, Second Edition

1998-09 .... Software in Programmable Components

PART 2 – PRODUCTS:

2.1 AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD):

A. Basic Description of Controllers and Control Functions:

1. Controllers shall be PLC based with 10” touchscreen HMI.
2. Controllers shall be manufactured separate from and shall be separate assemblies from the Burner Management (Flame Safeguard System)
3. Control functions:
   a. Control of burner firing rates to maintain steam header pressure.
   b. Parallel-positioning combustion control (air/fuel ratio, excess air) with flue gas oxygen trim.
   c. Flue gas recirculation (FGR).
   d. Boiler outlet draft.
   e. Boiler water level, 3 element system.
4. Control features:
   a. Operator interface on controller faceplates and touch screens. Operator interface shall include manual/automatic selection, manual loading, and displays that show set point, process variable, signal to actuator, process status and controller status. Touch screens have additional display requirements; refer to paragraph below.
   b. Provide separate dedicated controllers for each boiler and for the master steam pressure control. Fuel/air control loops, including flue gas recirculation (FGR) and oxygen trim may be incorporated into one station for each boiler. Boiler/economizer outlet draft and boiler water level control shall have separate stations for each item on each boiler. c. Variable frequency drives with manual bypass on forced draft fan motors.
5. Refer to the paragraphs which follow for complete detailed requirements.
6. Refer to Par. 2.2 for burner management controls.

B. Controllers: Multiple-loop programmable microprocessor or programmable logic (PLC) proportional-integral-differential (PID) solid state electronic controllers shall control all functions except burner management.

1. Accuracy: 0.1% analog inputs and outputs.
2. Resolution: 16 bit input and output.
3. Environment: 0 to 50 degrees C, 15% to 95% RH, non-condensing.
4. As a minimum, each controller shall have capability for four analog and four digital inputs, two analog and four digital outputs, and two PID loops.
5. Memory retention for twelve months minimum for power failure or for storage as spare parts.
6. Membrane push buttons with tactile feedback.

7. Displays shall be a combination of English language, color graphics, and digital with 0.5 percent resolution, visible from wide angle.
8. Bumpless manual/automatic transfer.
9. High and low alarms for all inputs.
10. Programming: Controllers shall have capability for quick (5 - 10 minutes) reloading of memory by operating personnel upon memory loss. Provide all software and hardware necessary to allow field downloading of configuration memory to the microprocessors.
11. Password Protection: Provide levels of password protection for all safety related options and parameters including all commissioning programming. Provide all passwords to Project Engineer (RE).
12. In the event of a controller fault, the controller shall have a dedicated relay output that results in the shutdown of the boiler and provides an alarm to a panel-mounted light and audible alarm. Failure of control system for one boiler shall not affect automatic and manual operation of other boilers.
13. Controllers and software that operate variable frequency drives shall be manufactured and tested in accordance with UL 508.
14. Controllers shall provide serial RS232/RS485 Modbus communication with computer workstation running latest Microsoft Windows based operating system. This includes data gathering and processing, report generation, monitoring, annunciation and control. It shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation.
15. All controllers, including those assigned to data processing, shall be same model and series.
16. Controllers shall be the current generation product that will be supported by the manufacturer, with parts and service, for a minimum of ten years from time of installation.
17. All controllers shall be mounted within specified control panels.
18. Examples of acceptable controllers: Allen Bradley “Compactlogix”.

C. Power Supplies: Provide separate uninterrupted power supply for each boiler controller. Any signal that is common to all boilers, such as plant master control signals, shall be isolated from all other boilers so that failure in one boiler circuit will not affect other boilers.

D. Touch Screen Operator Terminals:

1. Provide one touch screen control station and display for each boiler mounted on the boiler control panel. Touch screen shall be in complete communication with all controllers associated with the boiler and with the burner management system. Provide alternate control station to replace touch screen control functions if touch screen fails.
2. Control Station and Display Requirements:
   a. Local operation and programming of controllers, graphic display of information, alarm message display, historical and real time trending, remote controller tuning, x/y plots of

fuel air curve data for intuitive commissioning of controllers, Ethernet connectivity and standard Internet browser remote communication. Network to boiler control and burner management systems.

b. Selection of automatic or manual control of firing rate. Local manual control to increase and decrease the firing rate.
c. Indicate burner management control status and diagnostics in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off, all diagnostic information available from burner management system, continuous indication of flame signal.
d. Real time display of all connected process parameters including control output, set point, process variable, all data gathering and processing from all controllers associated with the boiler.
e. Display of all control system alarm messages and faults. History of alarms and faults and recommendations for troubleshooting.
f. Complete display and facilities to allow programming all controllers associated with the boiler or the master control. Burner management is excluded from this requirement.
g. Provide alternate means of automatic and manual operation of boiler firing rates and burner management status if touch-screen fails.
h. Provide continuous display of critical operating parameters, including but not limited to the following:
    1) Steam Pressure
    2) Water Level
    3) Draft Pressure
    4) Firing Rate

3. Touch Screen System Hardware and Software:
    a. 265 mm (10.4 inch) panel-mounted display, TFT with 256 colors, 640 x 480 pixel LCD resolution. Locate to allow easy viewing and access from operating floor.
    b. Aluminum case allowing entire enclosure to be rated NEMA 4x.
    c. Communication with SCADA program on computer work station.
    d. Multiple RS-485 Modbus communication interfaces.
    e. Field-replaceable backlight, real-time clock, battery-backed clock time stamps critical data, 8 MB on-board flash application memory, 512 MB memory card, application expanded memory card for historical, alarm and event storage, resistive analog touch screen with free formable to fit target shape.
    f. Operation interaction shall be touch-based allowing easy selection of screens, manual/automatic status changes, start/stop functions, set point changes, output

changes and PID tuning parameters without any special programming skills. Screen selection shall also be available through tactile feedback function keys.

g. Show facsimiles of each controller and clearly labeled English language and engineering unit display of the control parameters.
h. Graphic X/Y curve data plotting capability. When used in conjunction with fuel/air ratio control, provide automated fuel/air ratio curve and oxygen trim setpoint curve adjustment for rapid, error free burner tune-up. Only a single operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point.
i. Configuration software Microsoft Windows based. Provide all necessary software to allow field modification or expansion of the system including graphics drawing programs and data base builders. Systems based on “run time only” programs are not acceptable.

E. Drive Units and Actuators for Dampers, Fuel Flow Control Valves, Feedwater Flow Control Valves:

1. Electric drive units are required.
2. Electric drive units shall have continuous modulating duty cycle without any duty cycle or thermal motor limitations. Shall start instantaneously at full rated torque, stop instantaneously without coast or overshoot. Shall smoothly operate all connected devices without overload. Provide 100 percent duty cycle maintenance free motors that never overheat or burnout under stalled conditions. Gearing shall eliminate backlash. Movement shall be constant speed and shall be coordinated with the controlled process so that performance parameters remain within specified limits.
3. Additional Requirements for Electric Drive Units on Parallel-Positioning Combustion Control Systems:
   a. Drive units shall have precise positioning and repeatability to provide air-fuel positioning ratios with a maximum hysteresis of 2%.
   b. Provide continuous precise feedback signals from drive units to controllers.
   c. Provide auxiliary contacts to prove low and high fire positions, feedback signals are not permitted to perform this function within the VA. Belt-type drive units not permitted.
   d. Drive unit shafts shall be keyed to fuel flow control valves and damper shafts to eliminate the possibility of slipping.
   e. Drive units shall be industrial rated.
   f. All gearing shall be brass or better, no plastic gears of any kind are permitted.
4. Boiler outlet damper drive units may be different model than drive units for fuel valves and forced draft damper. Drive units shall be capable of 136 Nm (100 ft-lb.) torque minimum. Less powerful drive units may be utilized if certified as adequate by the burner manufacturer.

F. Variable Frequency Drives (VFD) for Forced Draft Fans:

1. Refer to Section 26 29 11 LOW-VOLTAGE MOTOR STARTERS, for electrical requirements. In addition, there shall be a VFD mounted operator interface unit that allows configuration of drive parameters and displays diagnostic information for troubleshooting.
2. Provide feedback system including motor speed and direction of rotation to combustion controller. Feedback transmitter must have no-drift guarantee. Feedback system shall not be affected by position of H-O-A switch on motor control system.
3. Provide noise filters.
4. The VFD shall automatically limit the rate of fan speed increase to that which will prevent an over-current trip in the event of a “step” speed increase of 0 – 100%.
5. Provide constant speed feature and operator-selectable air/fuel program in the controller for constant speed operation maintaining specified air/fuel ratios (excess air).
6. Forced draft fan damper operation is required in conjunction with operation of the VFD at the lower firing rates.

G. Transmitters: See Paragraphs, PRESSURE SENSORS AND TRANSMITTERS, TEMPERATURE SENSORS AND TRANSMITTERS.

H. Final Control Elements:

1. Fuel flow control valves, forced draft fan dampers, flue gas recirculation (FGR) dampers, variable frequency forced draft fan drives (VFD), feedwater control valves: Refer to Section 23 52 33, WATER-TUBE BOILERS.
2. Dampers in stacks and breechings: Refer to Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.

I. Uninterrupted Power Supplies:

1. Provide separate complete protected power conditioners for each boiler control and for master control. Power supply shall protect all computers, controls, instruments and accessories from damage due to ground leakage, spikes, sags, surges, transients and overloads in the incoming power supply.
2. Line interactive, UL 1449-rated, interactive digital display. Automatic internal bypass. Smooth sine wave output.
3. Suitable for ambient temperature of 44 degrees C (110 degrees F) in boiler room panel.
4. Hot swappable batteries.
5. Audible and visual alarms to signal failure of power supply.
6. This UPS system can be deleted from the project if controls furnished have integral protection from power supply irregularities listed above, and if software can be immediately reloaded by plant personnel.

J. Spare Parts and Tools:

1. Master control steam pressure transmitter: One complete unit, calibrated for the service.

2. Hardware and software sufficient for downloading and uploading all programming configurations with all the controllers.
3. Electric power drive unit: One of each size and type used

K. Detailed Control Functions:

1. Control of Burner Firing Rates to Maintain Steam Header Pressure:
   a. Automatic modulation of burner firing rates on all boilers to maintain set pressure of main steam header. Master controller receives signal from header pressure transmitter, processes and transmits signal to submaster controller for each boiler/burner. Submaster controls fuel flow and combustion air flow.
   b. Set Points and Performance: Accuracy plus or minus two percent of the set pressure when steam load changes do not exceed 20 percent of the maximum continuous rating of the largest boiler in service in a sixty second period. System oscillations shall be minimal.
      Set point _______kPa/psi
      Individual set point adjustment range: +/- 140 kPa (20 psi).
   c. Control Stations: Individual control stations for master and submaster controllers. Locate control stations on main instrumentation panel unless otherwise shown. Master controller shall have capability for two set points with easy selection.
   d. Low fire hold capability and user definable optimum ignition position.
   e. Interface with burner management system for automatic positioning of forced draft fan damper ,forced draft fan speed and fuel flow control valves during pre-purge, ignition, shutdown and post-purge.
   f. Interlocks to prove proper positions of forced draft fan damper ,forced draft fan speedand fuel flow control valves for ignition and running cycles. Refer to paragraph, BURNER MANAGEMENT SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
   g. The steam header pressure transmitter(s) shall be dedicated to header pressure control. Suppressed range transmitter(s), each with range +/- 20 percent of required set point. If two set points are required that are more than 138 kPa (20 psi) apart, provide two transmitters. Locate transmitters adjacent to main steam header. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
2. Parallel-Positioning Combustion Control (Air/Fuel Ratio, Excess Air):
   a. Boiler/burner submaster controller provides firing rate signals to separate drive units (actuators) for forced draft fan dampers and for each of the fuel flow control valves and to the variable frequency drive (VFD) of the forced draft fan. Air/fuel ratio maintained by firmware and software programming of the submaster controller. Software shall be factory-programmed for the specific application. Only tuning and scaling shall be performed in the field.

b. Hardware, firmware and software shall comply with UL 1998. Incorporate cross-limiting (air leading fuel on load increases, fuel leading air on load decreases) and deviation limiting (allowable tolerances on air/fuel ratio). Provide automatic burner shut down if deviation exceeds programmed limits or if there is a controller failure.

c. Provide feedback signals from drives and actuators. Fuel flow shall not increase until appropriate combustion air flow increase is proven. Combustion air flow shall not decrease until appropriate fuel flow decrease is proven. VFD feedback transmitters shall have “no-drift” guarantee.

d. Accuracy of control of drive units shall result in fuel-air positioning ratios that are specified by the burner manufacturer for efficient and safe operation with a maximum hysteresis of 2 percent. Excess air in flue gas shall conform to limits given below.

e. Manual control function accessible to operating personnel shall be confined to base loading the firing rate of the burner and shall not permit separate control of fuel or combustion air. All other manual functions shall be password protected intended to be accessible only to qualified technicians. If system is improperly placed in a manual control mode, the system shall shut down the boiler or maintain safe excess air levels at all times, within parameters that limit the carbon monoxide emissions to specified limits.

f. From low fire to high fire the air/fuel ratio (excess air) shall be programmed over at least ten evenly spaced increments of fuel input.

g. Control positions and display indications shall be linear in relation to firing rate. For example, 20% control position shall be 20% firing rate (20% of full load).

h. Mechanical connections between drive units and dampers and valves shall not have hysteresis and shall be keyed to eliminate slippage. Use of linkage systems are not acceptable.

i. Excess Air and Emissions Limits – New Burners: Refer to the boiler and burner specification.

j. Excess Air and Emissions Limits – Existing Burners:
Minimum excess air at all loads: 15%
Maximum excess air at 20 – 39% of maximum firing rate: 35%
Maximum excess air at 40 – 100% of maximum firing rate: 25%
Consult Project Engineer if flue gas carbon monoxide exceeds 200 parts per million (ppm) within the excess air limits specified above.

3. Automatic Flue Gas Oxygen Trim System:

a. Boiler/burner submaster air/fuel controller shall utilize signal from flue gas oxygen analyzer and vary the combustion air flow to maintain the specified air/fuel ratio (excess air) at all firing rates 20 percent of maximum firing rate and greater.

b. Operation and Performance:
   1) Separate characterized set point curves for each fuel, minimum ten points per fuel. A single curve with biasing for the other fuel is not acceptable. Automatic change over of set point curves when type of fuel being fired is changed.
   2) Maximum deviations from set points shall not exceed ten percent at any firing rate. Combustion shall not generate carbon monoxide (CO) in excess of 200 parts per million (ppm) at any time.
   3) At firing rates below 20 percent of maximum steam flow, trim shall automatically return to null position (no trim).
   4) Variable gain to decrease output sensitivity at low loads.
   5) Adjustable high and low trim limiting. Excessive high or low trim correction, low excess air, or oxygen analyzer failure shall actuate audible and visual alarm on the boiler submaster air/fuel ratio controller. Analyzer failure shall cause system to go to null position.
   6) Manual trim output shall revert to null setting when system is placed in automatic control.
c. During burner start-up and adjustment of air/fuel ratios (excess air) by service technician, trim shall be on manual control at null position.
d. Refer to Paragraph, FLUE GAS OXYGEN ANALYZERS.

4. Flue Gas Recirculation (FGR) Control:
   a. Automatic operation of FGR damper to control NOx emissions to required limits and to provide purging of combustibles from the FGR ducts during the pre-purge cycle.
   b. Automatically disable FGR during burner start-up cycle due to potential for flame instability. Automatically enable the FGR after the boiler flue gas outlet temperature reaches a minimum of 150 degrees C (300 degrees F).
   c. Interface with burner management system with interlocks to prove FGR dampers in proper position for pre-purge prior to ignition. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.
5. Boiler Outlet Draft Control:
   a. Automatically modulate position of boiler or economizer outlet damper to maintain constant negative pressure (draft) at the flue gas outlet of the boiler. Utilize feed forward signal from the boiler/burner submaster air/fuel controller to enhance control response. Position damper open and closed during boiler start-up and shut-down cycles.
   b. Maintain draft at negative 25 Pa (0.1 inches WC) plus or minus 10 Pa (0.05 inches WC). Provide local gauge with remote indication at operator interface.

c. Panel-mounted automatic controller, with manual/automatic feature and set point adjustment, for each boiler. Locate on main instrumentation panel unless otherwise shown.

d. Draft sensor, transmitter, and outlet damper actuator for each boiler. Refer to Article, PRESSURE SENSORS AND TRANSMITTERS.

e. Automatically position damper as required for pre-purge, burner ignition and shut down. Provide damper position switch interlocked with burner management system. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.

6. Boiler Water Level Control:

a. Automatically modulate the position of feedwater control valve on each boiler to maintain the water level in the boiler within plus or minus 50 mm (2 inches) of set point with instantaneous load swings of 20 percent of boiler capacity. Adjustable set point.

b. Type of System:

1) Three-Element System: Utilize boiler steam flow signal, boiler water level signal and boiler feedwater header pressure signal. Adjustable signal gain. Provide single-element (drum level) operation from low fire to 20 percent of maximum boiler load. Provide automatic switchover from single-element to three-element operation and vice-versa at 20 percent load.

c. Boiler Water Level Sensors:

1) Differential Pressure Transmitters: Provide on water tube boilers. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.

d. Steam Flow Sensors: Refer to Paragraph, FLOW METERS.

e. Feedwater Pressure Sensors: Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.

f. Controller: Controllers for two and three element systems shall include: manual/auto control station and indicators showing signal level to actuator, set point and actual water level, steam flow rates and totals and boiler feedwater flow rates and totals if flow meters are included. Locate on main instrumentation panel unless otherwise shown. For controller requirements for fire tube boilers, refer to Section 23 52 39, FIRE-TUBE BOILERS.

g. Set point position as recommended by boiler manufacturer.

7. Boiler and Economizer Efficiency Calculation and Display: If not provided on the computer work station, provide continuous automatic calculations and indication of heat-loss combustion efficiency based on flue gas outlet temperature of economizer (or boiler if economizer is not provided), flue gas oxygen, and type of fuel in use. Base calculation

method on ASME Performance Test Code Form Number 4.1b, HEAT LOSS EFFICIENCY, with no consideration for boiler radiation and unaccounted losses.

2.2 BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES

A. Complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing. System shall include microprocessor programmer, self-checking ultraviolet (UV) flame scanner and amplifier (see below for limited exceptions), burner cycle display, first-out diagnostic annunciation display, burner safety shut down interlocks, communication with monitoring systems, and accessories. Mount controllers, control switches and displays in and on individual boiler control panels. Refer to Paragraph, BOILER/BURNER CONTROL PANELS. All interlock devices shall be designed to permit periodic operational testing, including set points and trip points, without changing set points or programming.

1. Controller shall be manufactured separately from the Burner Control System controller.
2. Controller shall be a separate and individual assembly from any other controller.
3. Controller shall have its own mounting and wiring base to permit the controller to be replaced without disturbing any wiring or other components.

B. Code Compliance: Conform to NFPA 85. All components UL listed, FM approved.

C. Operate on 102 to 132 volts; 60 Hertz AC. Operating ambient temperature range 0 °C to 52 °C (32 °F to 125 °F).

D. Flame Scanners: Provide self-checking ultraviolet (UV) scanners except where burner manufacturer provides documentation that burner design precludes reliable operation with UV. When UV is unreliable, provide infrared scanners with “learn function” of unique flame characteristics.

1. Self-checking UV scanners shall have minimum checking frequency six times per minute. Position scanners so that they do not view the ignition spark. Scanner sight tubes must be non-reflective to avoid the scanner detecting the reflection of the ignition spark. UV non-self-checking scanners are not permitted because they can fail in an unsafe mode on continuously operated burners.
2. Infrared (IR) systems must have a “learn function” that can be programmed on site for the particular pilot and main flame characteristics including amplitude and radiation levels and to reject background radiation. Submit layout drawings showing that scanners will be positioned to not view refractory or any element of the furnace that can radiate IR wavelengths.

E. Control Features:

1. Automatic recycling on high steam pressure only.
2. Interrupted ignition.
3. Electronically prevent UV scanner sensing ignition spark. Methods include early spark termination or by phasing the firing of the ignition spark off cycle from the scanner activation.
4. Flame failure response time four seconds maximum.

5. Ten seconds trial for ignition except 15 seconds permitted on heavy oil fuel.
6. Pre-purge timing set for 4 air changes on fire tube boilers and 8 air changes on water tube boilers per NFPA 85. The exact timing must be determined by the boiler manufacturer. For example, typical pre-purge timing with wide open forced draft damper and forced draft fan at full speed has been 30 seconds for packaged fire tube boilers and 2 minutes for packaged water tube boilers.

F. Provide components that can be easily removed from the panel without disturbing wiring.

G. Memory storage and self-diagnostics of at least six most recent causes of burner shutdown, which can be accessed by operating and service personnel. Diagnostics shall include all individual interlocks.

H. Provide Modbus RS232/RS485 and modem interface to allow remote access to detailed boiler plant operating data and memory. Provide interface with SCADA (Supervisory Control and Data Acquisition) software on computer workstation to allow access to burner management memory and to current operating information. In addition, provide a BACnet (read only) interface to the central medical center DDC control system.

I. Burner cycle indication on face of panel: Show instantaneous status of start up, run and shut down program. Provide indicator for control power on, ignition, main fuel valve open, and flame failure.

J. Reset button on face of panel.

K. Annunciator Display and Alarm:
1. Locate display on outside face of panel between 1200 mm and 1500 mm (4 feet and 5 feet) above the floor.
2. English language read-out with individual identification of specific interlocks. Where two or more interlocks serve the same function, individual display of each interlock is not required.
3. Indicate burner status in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off.
4. Continuously indicate flame signal strength.
5. Provide first-out annunciation, including English language message, and audible alarm (horn) for each of the following interlocks:
   a. Flame failure.
   b. Purge airflow low.
   c. Combustion air low.
   d. False combustion air (switch activated with combustion air flow).
   e. High main gas fuel pressure.
   f. Low main gas fuel pressure.
   g. High oil pressure.
   h. Low oil pressure.

i. Low igniter (pilot) gas pressure.

j. Low oil temperature (heated oil systems only).

k. Fuel safety shut-off valves not closed prior to ignition cycle.

l. Low fire position not attained prior to ignition cycle.

m. Low atomizing media (steam or air) static pressure at atomizing media service connection to burner piping.

n. Low atomizing steam/oil differential pressure. Where burner does not maintain differential pressure provide low atomizing media pressure at burner.

o. High steam pressure.

p. Low water cutoff.

q. Low control air pressure (if pneumatic feedwater control valve drive units or other controls are furnished).

r. Flue gas recirculation (if provided) improper damper position.

s. Low flue gas oxygen.

t. High furnace pressure (if outlet draft control system furnished).

u. Building combustion air intake louver closed or make-up air ventilation system not operating.

6. Audible alarm (horn): Sounds upon all burner shutdowns except automatic recycle shutdowns on steam pressure. Provide silencing control, which automatically resets when burner control is reset.

L. Pre-Purge Timing: Integral with the programmer. Non-adjustable after initially set to suit boiler pre-purge requirements.

M. Auxiliary relays: Industrial type rated for the service, enclosed contacts.

N. Selector switches, push buttons and control switches: Heavy duty, industrial type.

O. Safety shut down and manual reset required for, but not limited to:

1. Flame signal detected prior to ignition cycle.
2. Pre-ignition interlock open during pre-purge.
3. High fire purge interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to high fire.
4. Low fire interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to low fire.
5. Igniter (pilot) or main burner fails to ignite.
6. Malfunction of flame detector.
7. Malfunction of programmer.
8. Malfunction of flame signal amplifier.
9. Combustion air proving switch actuated prior to start-up of forced draft fan.
10. Lock-out interlock open during pre-purge (after 15 seconds), ignition or run period.

11. Interlock open.
12. Flame failure.
13. Building combustion air intake louvers closed or make up air ventilation system not operating.

P. Burner Safety Shut Down Interlock Devices:

1. Basic Requirements:
   a. Adjustable Set Points.
   b. Maximum Set Point Deviation: 5% of full scale.
   c. Minimum Repeatability: 2% of full scale.
   d. Minimum Set Point Accuracy: 10% of full scale or 20% of set point.
   e. Scale range shall allow set points to be within 30 to 70% of full scale.
   f. Safety interlock devices shall be separate from operating control elements, such as feedback devices. This is to avoid having the failure of an operating control device preventing the operation of the safety device.
2. Provisions for Testing of Interlocks:
   a. Installation of all interlock devices shall permit testing of set points and control operation without removing or disconnecting the devices and without adjusting set points of devices. Provide permanent connection points for test instruments, such as manometers and pressure gages, on sensing piping and tubing. Where necessary, provide lockable valves to allow temporary isolation of device from the service to allow testing of the device.
   b. All interlock device wiring shall start out at and end at a terminal strip in the main cabinet. No device shall be wire directly to another device in series without returning to the main cabinet's terminal strip first. All series wiring will take place at the terminal strip.
   c. Provide all necessary control system passwords, wiring diagrams, and step-by-step written instructions specific to that facility to Project Engineer to facilitate all interlock testing required by the latest edition of the VHA Boiler Plant Safety Device Testing Manual.
3. Forced Draft Fan Motor Operation Interlock: Provide current relays on each phase of power circuits to fan motor. For variable speed drives, provide signals to control system from VFD fault and run contacts and signals from VFD shaft speed feedback to prove proper fan speed for purging, low fire ignition, and for each burner load point. Any disconnects or other power shut-off devices between the location of the interlock devices and the motor shall also shut down the power supply to the burner management control system.
4. Atomizing Air Compressor (when provided) Motor Energized Interlock: Provide current relays on each phase of power circuits to the motor. In the power supply to the motor there shall be no disconnects or other power shut-off devices between the location of the interlock devices and the motor.

5. Forced Draft Fan Damper, Boiler Or Economizer Flue Gas Outlet Damper (if provided) Pre-Purge Position Interlock: Prove dampers wide open for pre-purge. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage. Parallel positioning systems may have the interlock switches in the drive units.
6. Flue Gas Recirculation (FGR) Dampers (if provided) Position Interlock: Prove dampers positioned as required by burner manufacturer for pre-purge and firing. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage.
7. Pre-Purge Airflow Interlock:
   a. Sense differential pressure between two points in combustion air system where the differential pressure at high fire is significant, such as several inches water column. There must be no intervening dampers. This is typically between the windbox and boiler outlet.
   b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
   c. UL listed, FM approved.
   d. Provide air pressure sensing connections for test manometer so that air flow switch settings can be verified.
   e. Trip point shall prove at least 70% of maximum airflow.
8. Combustion Air Proving Interlock:
   a. Sense differential air pressure across the forced draft fan with no intervening dampers.
   b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
   c. UL listed, FM approved. Provide switch designed for “false combustion air” feature on start-up interlock.
   d. Provide air pressure sensing connections for test manometer so that switch settings can be verified. Demonstrate that trip point is within 10% of minimum differential pressure over the firing range of the burner.
9. High And Low Main Burner Fuel (Gas and Oil) And Low Igniter (Pilot) Gas Pressure Interlocks:
   a. Solid-state sensor, mercury switch, automatic reset. Provide graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements either on the switch or as a part of the controller. Switch movements shall have bushings to eliminate metal-to-metal wear.
   b. Gas pressure switch ratings: Sustained pressure capability shall exceed two times lock-up of nearest upstream regulator.

c. Oil pressure switch ratings: Sustained pressure capability shall exceed set pressure, plus accumulation, of oil pump safety relief valve. On heated oil system, sustained temperature capability shall exceed maximum operating temperature.

d. Low gas pressure switches shall include impulse dampener to reduce the effects of pressure dips during start-up.

e. Mechanical movements shall have bushings to eliminate wear of metal parts.

f. Approvals: UL listed, FM approved.

g. Switch Locations: Must be located where pressure is constant, as controlled by pressure regulator (if provided) on fuel train. Must be upstream of modulating fuel flow control valves.

h. Set points shall be within 20% of the normal operating pressure.

i. High pressure switches shall be piped to the service with lockable isolation valve and valved test connection so that switch can be set and tested using compressed air.

10. Low Oil Temperature Interlock (Heated Oil Only):

a. Type: Solid-state sensor or sealed snap-acting switch, automatic reset. Provide graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirement either on the switch or as part of the controller.

b. Ratings: Sustained temperature capability shall exceed maximum oil temperature requirement.

c. Approvals: UL listed.

d. Location: Ahead of safety shut off valves.

11. Low Atomizing Media Pressure, Differential Pressure And Flow Interlocks:

a. Type: Mercury switches, graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements, automatic reset. Switch movements shall have bushings to eliminate metal-to-metal wear.

b. Rating: Shall exceed pressure setting of nearest upstream relief valve.

c. Provide siphon on steam connection to protect sensing element from live steam.

d. Approvals: UL listed.

e. Locations and types of switches on atomizing media piping: Two switches required for each burner, a static pressure switch on atomizing media supply ahead of differential pressure control valve, and differential pressure flow switch with flow meter orifice on atomizing piping adjacent to burner. On burners that maintain an approximately constant differential pressure between the atomizing steam and oil, provide a steam/oil differential pressure switch instead of the flow switch at the oil burner.

Burners with individual air compressors for air atomization shall be provided with one air pressure switch and compressor motor interlocks as specified above.

12. Main Fuel (Gas And Oil) Automatic Safety Shut-Off Valves Proof-Of-Closure (Over Travel) Interlocks. Provide on all automatic safety shut off valves to prove closure prior to igniter (pilot) ignition. Provide manually-actuated test circuits through the proof-of-closure switches that will demonstrate that the switches close and open properly and that the circuit is connected to the burner management system.
13. Low Fire Position of Fuel Flow Control Valves Interlocks: Sealed snap-acting switches. Actuate switches by levers attached directly to fuel valves. As an option, the switch lever may be pinned to the jackshaft to which the fuel valve proportioning cams are also pinned or provide UL listed and FM approved position sensor on the motor which positions the jackshaft to which all the operating levers are pinned.
14. High Boiler Steam Pressure Limit and Interlock: Operating limit switch allowing burner recycling and safety shut down interlock switch. Refer to Paragraph, BOILER TRIM, in Section 23 52 33, WATER-TUBE BOILERS.
15. Low Boiler Water Level Interlocks: Primary and auxiliary low water burner shut down interlocks. Refer to Paragraph, BOILER TRIM, in Section 23 52 33, WATER-TUBE BOILERS. Operation of auxiliary low water cutoff shall interrupt the power supply to the burner management control system.
16. Boiler Control Compressed Air Pressure Interlock (Pneumatic Control Systems):
    a. Type: Mercury switch, graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements, automatic reset.
    b. Rating: Shall exceed maximum relief pressure of nearest upstream relief valve.
    c. Approvals: UL listed.
17. Low Flue Gas Oxygen Alarm and Interlock: Signals from flue gas oxygen analyzer providing low oxygen alarm and low oxygen burner shut down. Refer to Paragraph, BOILER FLUE GAS OXYGEN ANALYZER SYSTEMS.
18. High Furnace Pressure Interlock:
    a. Required only for boilers that have boiler outlet draft control system.
    b. Sense static pressure in furnace.
    c. Diaphragm-actuated snap-action switch, adjustable set point, set point indicating scale, designed for maximum system pressure.
    d. UL listed, FM approved.
    e. Connect to the service with a lockable isolation valve and valved test connection to allow the switch to be set and tested with pressurized air source.
19. Building Combustion Air Intake Interlock: Provide devices to prove outside air building wall louvers are open or H&V unit is in operation.

Q. Automatic Programming Sequence:

1. After personnel select the fuel to be burned and operate the burner start switch, the control system shall automatically perform the following operations:
2. Prove proper operation of all interlocks except purging interlocks or prevent further progress.
3. Open all air dampers fully. This includes all dampers (if provided) in the boiler outlet breeching and stack system.
4. Position flue gas recirculation damper (if provided) as required by burner manufacturer to purge flue gas from recirculation duct.
5. Prove 70% of maximum air flow through the boiler and prove all air dampers open wide and flue gas recirculation damper (if provided) in proper position.
6. Pre-purge eight air changes for water tube boilers and four air changes for fire tube boilers.
7. Return forced draft fan dampers and fuel flow control valves to low fire position.
8. If boiler outlet damper is provided, retain outlet damper wide open. If outlet draft damper modulating control system is provided and excessive draft due to wide-open damper is incompatible with the burner, automatically position the outlet damper to an acceptable position for burner ignition.
9. Prove low fire start position.
10. Sensing of flame prior to this shall cause shutdown.
11. Energize igniter and open igniter fuel automatic safety shut-off valves. Prove igniter flame in ten seconds or provide shutdown.
12. On systems with ultraviolet flame scanners, terminate ignition spark five seconds before main fuel valves open.
13. Open main fuel safety shut-off valves for fuel selected. Close igniter fuel valves within ten seconds after main fuel valves open (15 seconds on heated oil).
14. Prove main flame or provide shutdown.
15. Place flue gas recirculation damper (if provided) in modulating or in fixed position as required by design of burner furnished.
16. If provided, release boiler/economizer outlet draft control damper to modulation.
17. Release burner from low fire position to automatic or manual firing rate control.
18. Provide 15 second post purge at end of burner firing cycle.
19. Close all dampers upon completion of post purge.

R. Spare Parts:

1. One flame control programmer chassis complete.
2. One flame control amplifier complete.
3. One flame scanner complete with connecting leads.
4. Twelve lamps for each type of replaceable lamp.
5. Two of each type of relay and timer.

2.3 MAIN INSTRUMENTATION AND CONTROL PANEL:

A. Type: One free-standing factory-assembled steel enclosure with control stations, control switches, instruments and indicators on panel front and controllers, relays and other components mounted on interior sub-bases. NEMA ICS-6, Type 12 rating. Refer to drawings for arrangement and overall dimensions.

B. Panel Construction:

1. Minimum 3.5 mm (0.134-inch) thick steel sheet with steel angle or bar reinforcement. Provide vertical reinforcement from top to bottom of panel between each large instrument opening. Provide horizontal reinforcement above and below each large instrument opening.
2. Provide sufficient reinforcement to prevent any warping or displacement due to weight of equipment mounted on and within panel.
3. All corners and edges shall be smooth.
4. Rear Access Doors: Sufficient quantity to cover full height and width of panel, three-point latches with key-type locks, three hinges per door, or piano-type hinges.
5. Finish:
    a. Exterior: Undercoat of rust-resistant primer, finish coats of textured spatter paint, dark gray.
    b. Interior: Undercoat of rust-resistant primer, finish coats of enamel, light gray or white.
6. Provide duplex 120 v. GFI receptacle inside the panel.
7. Provide fan-type ventilation if necessary to protect equipment from overheating. Assume boiler room temperature of 38 degrees C (100 degrees F).

C. Master Steam Pressure Control Station: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Unit shall be flush mounted on panel front.

D. Boiler/Burner Submaster Control Stations: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Units shall be flush mounted on panel front.

E. Recording Systems: Refer to Paragraph, RECORDERS.

F. Touch Screens: Refer to Paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM.

G. Pressure Gages: Flush mounted, ½ percent accuracy, 150 mm (6-inch) dial diameter, micrometer adjustable pointer, solid front, blow-out disk in rear, back connected, and of indicated range. Provide gage cock within panel for each gage. Provide gages for steam header pressure, boiler feed header pressure for each boiler, fuel header pressures.

H. Push Button Stations and Indication Lights for Pump Control: Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS. Lights shall be oil-tight, standard industrial construction, 120-volt, utilizing lamps which are readily available. Lenses shall be red and green colored, held in place by threaded ring. Push button stations shall be flush mounting, oil tight, momentary contact. Provide non-latching lamp test control on main panel.

I. Boiler Economizer Temperature Indicator Systems:
   1. RTD system measuring temperature at four points: feedwater in and out, flue gas in and out. Separate indicators, graduated 0 – 600 °F
   2. Accuracy: Plus or minus 5 °F.
   3. Mounting: Mount indicators on instrumentation panel.
   4. Include Modbus communication with computer workstation (present or future).

J. Annunciator:
   1. Provide system for monitoring alarm functions listed below. Annunciator shall include alarm lights, alarm bell, integral test and acknowledge push buttons. Include Modbus communications for use with computer workstation.
   2. Type: Multiple rectangular back-lighted windows on which alarm functions are engraved; separate window for each function. Provide test and acknowledge controls.
   3. Construction:
      a. Window Size: 44 x 75 mm (1.75 x 3 inches) minimum.
      b. Lamps: Minimum of two per window.
      c. Operating Mechanisms: Solid state electronic, accessible for repair without removing entire annunciator from panel. Provide all equipment for complete system.
      d. Bell: 150 mm (6 inch) diameter, surface mounted.
   4. Operating Sequence:
      a. Condition Normal: Bell and light off.
      b. Condition Abnormal: Bell on; light flashing.
      c. Acknowledge: Bell off; light on steady.
      d. Condition Returns to Normal: Bell and light off.
      e. Test: Bell on; light flashing.
   5. Alarm Sensing Systems: Provide complete wiring, controls, conduits, and accessories.
      a. Condensate Storage Tank and Feedwater Deaerator Storage Tank High and Low Water Level Alarms (4 functions): Actuated by sensors mounted on storage tanks. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
      b. High and Low Steam Header Pressure (2 functions): Actuated by adjustable automatic reset UL listed pressure switches. Range of adjustable set point 40-180 psi, 5 psi maximum differential. Provide steam siphon loops, shut-off valves.
      c. Emergency Gas Valve Closed: Actuated by switch provided with valve assembly.
      d. Oil Tanks – High and Low Level (2 functions per tank): Separate high and low level indications for each tank. Actuated by oil tank level monitor system. Refer to Section 23 10 00, FACILITY FUEL SYSTEMS.
      e. Low Excess Air – Boiler (1 function per boiler): Actuated by flue gas oxygen analyzers. Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS.

f. High Natural Gas Header Pressure: Actuated by adjustable, automatic reset, pressure switch connected to gas header. Switch shall be UL listed for natural gas service. Provide shut-off cock between gas header and switch.

g. LP Igniter (Pilot) Gas in Use – For Emergency Only: Actuated by adjustable, automatic reset, UL listed, FM approved, high pressure switch mounted on LPG header. Range of set point 1-10 psi, emergency rating 30 psi.

h. Fuel Oil Temperature – High and Low (Heated Oil Only): Actuated by temperature switches located on the fuel oil header. Automatic reset, adjustable set point and dead band, UL listed, set point range 50 – 150 °F. UL listed, removable without draining system, set point indicator.

i. Low feedwater pressure (1 function per header): Actuated by pressure switches on feedwater headers.

j. Input/Output (I/O) Modules: Provide 20% (2 minimum) installed spare I/O of each type for computer data acquisition system.

K. Emergency Fuel Safety Shut-Off Valve Control: Provide maintained contact, emergency safety shut-off push-pull control switches with mushroom heads on outside face of panel and at outside personnel doorways. The shut-off shall shut down main and igniter emergency safety shut-off valves from power source shown and shut down all other fuel sources. Valves shall close when switch is pulled out.

L. Remote Registers for Fuel Meters: Refer to Paragraph, FLOW METERS.

M. Clock: Microprocessor-driven digital, 60 mm (2.5 inch) high wide angle LED display, selectable 12/24 hours, enable/disable automatic daylight savings time changeover, enable/disable alternating time and date, seven year battery-back-up memory, time base accurate to plus or minus two minutes per year.

N. Nameplates: Provide engraved plastic laminated nameplates for all devices on front of panel. Nameplates shall have white letters on black background. Mount with screws or rivets. List equipment title and identification number, such as “BOILER FEED PUMP P-1.” Do not use abbreviations.

O. Auxiliary relays: Industrial type rated for the service, enclosed contacts.

P. Selector switches, push buttons and control switches: Heavy duty, industrial type.

Q. Wiring and Piping Methods:

1. All devices mounted in and on panel shall be factory-wired and piped.
2. All electrical contacts shall switch the phase conductor.
3. Electric wiring: Conform to NFPA-70, all wiring in troughs, terminations in industrial class terminal blocks, terminals numbered for identification, 20 percent extra terminals. All wiring color coded and numbered using numbering system that identifies the destination. There shall be no exposed wiring connections exceeding 120 volts inside the panels. Refer to

Section 23 21 11, BOILER PLANT PIPING SYSTEMS, and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS and CABLES (600 VOLTS AND BELOW).

4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.

R. Spare Parts Required:

Lamps: Six of each type in panel and instruments.

Touch-up paint for panel: One pint.

S. Seismic Design: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.4 BOILER/BURNER CONTROL PANELS:

A. Type: Individual boiler/burner control panels with control stations, control switches, instruments and indicators on panel fronts and controllers, relays and other components mounted on interior sub-bases.

Panels shall be freestanding.

B. Panel Construction:

1. NEMA ICS-6, Type 4. Freestanding panels shall be minimum 3.5 mm (0.134 inch) thick steel sheet with steel angle or other reinforcement. Boiler-mounted panels shall be minimum 1.9 mm (0.075 inch) thick steel sheet. Provide sufficient reinforcement to prevent any warping or displacement due to weight of equipment mounted within panel. All corners and edges shall be smooth. Mount all equipment on sub-bases. Mount switches, reset buttons, indicators and instruments on outside face of panel.
2. Access doors shall be full height and width of panel, dust tight gaskets, key-type locks. On freestanding panels, doors shall have three-point latches and three hinges or piano hinges.
3. Exterior finish: Undercoat of rust-resistant primer, finish coats of enamel. Color same as instrumentation panel or boiler manufacturer’s standard color if panel is boiler-mounted.
4. Interior finish: Undercoat of rust-resistant primer, finish coats of enamel, white.
5. Identification: All elements on face of and on interior of panels shall be labeled. Nomenclature shall be keyed to wiring diagrams.
6. Provide fan-type ventilation if necessary to protect equipment from overheating. Assume environment at 43 degrees C (110 degrees F).

C. Burner Management System with Annunciator: See Paragraph, BURNER MANAGEMENT SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.

D. Boiler Control Stations or Touch Screens, burner management displays and resets: See Paragraphs, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.

E. Draft Gages: See Paragraph, DRAFT GAGES.

F. Control switches on face of panel:
    1. Fuel selector.
    2. Burner start and stop selector (off-automatic-on).
    3. Circuit breaker for power to burner control system.
    4. Alarm silence.
    5. Forced draft fan start-stop for D-type water tube boilers.
    6. Burner stop switch with mushroom head.
    7. Reset for burner management system.

G. Boiler water level alarm on face of panel (non lock-out):
    1. Provide separate visual indications and audible alarm (bell) for high water and low water. Low water alarm is separate from low water cutouts and set at higher level than low water cutouts.
    2. Indicating lights: Industrial, transformer type, removable amber lenses. Burner status and shut down annunciator specified above may be used. Standard water level alarm display of water level control manufacturer may be used.
    3. Alarm bell: 150 mm (six inch) diameter. Provide silencing control, which is automatically deactivated when another alarm condition occurs.

H. Horn and bell: Mounted high on exterior of panel, audible throughout the boiler plant. The horn is for burner management system alarms and the bell is for high and low water level alarms (not burner cutoff) (See Paragraph G).

I. Wiring and Piping Methods:
    1. All devices mounted in and on panel shall be factory-wired and piped.
    2. All electrical contacts shall switch the phase conductor.
    3. Electric wiring: Conform to NFPA-70, all wiring in troughs, terminations in industrial type terminal blocks, terminals numbered for identification, 20 percent extra terminals. Wiring shall be color-coded and numbered with numbering system that identifies the destination of each wire. There shall be no exposed wiring connections exceeding 120 volts inside the panels. All field wiring shall be brought to terminal strip in the panel. No wiring in series from one safety device to the next device is permitted.
    4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.

J. Panel Certification and Testing:
    1. Manufacture and inspection of completed panels, including all wiring and components, shall comply with UL 508.
    2. Complete cabinets shall be factory tested and certified. The panel shall be labeled as complying with UL 508. A copy of the wiring diagram shall be placed in the cabinet prior to shipment.

2.5 COMPUTER WORK STATION AND PROGRAMMING:

A. The individual boiler plant controllers and instrumentation system shall be networked with a central computer workstation to provide remote operation of the controllers, custom graphic display of information, alarm message display, report generation, historical trending and remote tuning of controllers. All control functions shall be accomplished within the individual controllers and shall be monitored by the central computer so that the integrity of the control system shall not be dependent on the status of the central computer or the interconnecting network. Burner management (flame safety control) systems shall not be controllable from the workstation but shall be monitored from the workstation for status and access to historical data. Modem and software shall provide remote communication with diagnostic and status indications.

B. Hardware:

1. Microsoft Windows based desktop computer workstation with keyboard, mouse, two speakers, color graphic monitor, alarm printer, logging printer, uninterrupted power supply. Equip with latest version Microsoft Windows operating system compatible with SCADA software furnished. The system shall be designed so that additional workstations and peripheral equipment can be added in the future. Provide all devices necessary for complete access to all features of the programs applied.
2. Desktop Computer: Comply with requirements published by SCADA software supplier for optimum performance of software furnished. System must include hardware as recommended by Microsoft for installation of Windows Business operating system. Minimum requirements are Intel Core 2 Duo processor, 4 MB L2 cache, 2.4 GHz, 1066 FSB; 4 GB 600 MHz DDR2 SDRAM memory ECC(2 DIMMS); dual hard drives each 400 GB SATA, nVIDEA QUADROFX4400 512 MB graphics, DVD+/-RW optical drive, integrated gigabit Ethernet, 250 MB Iomega Zip internal drive, sound card, high density 1.44 megabyte 88 mm (3.5 inch) drive floppy disk, audible alarm and a battery-backed clock which counts seconds, minutes, hours, days and years. Provide two parallel ports and two serial ports, minimum.
3. Digital Flat Panel Color Monitor: TFT, 475 mm (19 inch) diagonal (nominal) screen with capability of 1600 by 1280 pixels resolution, non-interlaced, dot pitch 0.31 maximum. Minimum of True 16bit colors supported. Energy-Star compliant.
4. Keyboard: ASCII standard, QWERTY-style, enhanced 101-key consisting of at least 32 dedicated function keys and a 12-key numeric data entry section. Keys shall have tactile feedback and be permanently and clearly labeled. In addition, a set of arrow keys shall be provided for moving from the current screen of data to “next screen”. Function keys shall have custom legends for each key to allow report generation, graphic display selection, alarm silencing, and data retrieval with single keystrokes. Provide removable continuous Mylar faceplate to exclude dust and spills.

5. Mouse: The operator interface shall minimize the use of the typewriter style keyboard through the use of a mouse and “point and click” approach to menu selection. Users shall be able to access features of the program from graphical displays through the use of the mouse.
6. Alarm Printer: Impact printer, 9-pin dot-matrix type. The printer shall have a minimum 96 character ASCII character set based on ANSI INCITS 154. The printer shall have tractor feed with adjustable sprockets for paper width up to 380 mm (15 inches), print at least 132 columns per line and have a draft quality speed of 680 characters per second. Character spacing shall be selectable at 10, 12 or 17 characters per 25 mm (one inch) at front panel. The printer shall utilize sprocket-fed fanfold paper. The printer shall have programmable control of top-of-form. The sound level of the unit shall not exceed 55 dBA at 1500 mm (5 feet). Provide one box of 2000 sheets of printer paper.
7. Logging Printer: Black/color inkjet type, 20 ppm black and white – 15 ppm color – draft quality, minimum 8 scalable fonts, 4800 x 1210 dpi color, 16 mb RAM, capability of letter and legal paper size.
8. Speakers: Provided by computer manufacturer.
9. Uninterrupted Power Supply: Provide complete protected power conditioner. Line interactive, UL 1449 rated, interactive digital display. Power supply shall protect computers, controls, instruments and accessories from damage due to ground leakage, spikes, surges, sags, transients and overloads in the incoming power supply. Smooth sine wave output. Hot swappable batteries. Audible and visual alarm to signal failure of UPS.
10. Provide a desk unit for support of microcomputer, terminals and peripherals. The desk shall have a 600 x 760 mm (24 x 30 inch) workspace in addition to space for equipment. Desk shall have at least two drawers.

C. Supervisory Control and Data Acquisition (SCADA) Software:

1. Generally available non-custom system compliant with latest version of Microsoft Windows. Shall use Windows Open Systems Architecture (WOSA), such as in its use of dialog boxes and menus. Local system with capability for future networking. All features shall be supported on the in-plant hardware specified. The software shall be a complete package requiring no additional software to configure or run the features of the program. Program shall not require hardware “dongle” keys for licensing. The program shall be completely configured to perform all required functions at the required speed and with complete accuracy.
2. Configuration shall be accomplished from the keyboard or the mouse. All configuration changes shall be capable of being made while the system is on-line (operating) without interfering with the normal functions of the program. No programming, compiling or linking shall be required to configure the system.

3. Provide complete user documentation in electronic format, including examples of how to operate the various modules of the system. Provide keyword and specific text search features.
4. On-line “help” facility, based upon Windows standard Hypertext. This shall support full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.
5. Provide pre-emptive multitasking to ensure that common Windows actions are permissible and do not interfere with I/O communications, processing of data, alarming, and the integrity of the real-time and historical data.
6. Functions shall be available to support the following:
    a. Analog and Digital Input/Output.
    b. Analog and Digital Alarm.
    c. Analog and Digital Register.
    d. Boolean Logic.
    e. Calculation: Includes add, subtract, multiply, divide, parentheses, absolute value, square root, exponentiation, logs, relational operations, change floating point values to integers.
    f. Device Control.
    g. Event Action.
    h. Fanout.
    i. Multi-state Digital Input.
    j. Program: Sequencing, monitoring, process control.
    k. Real-time Trend.
    l. Text.
    m. Timer.
    n. Totalizer.
7. Wherever possible, the device communications program will perform error checking on messages. This will include lost response and data error. Should communications errors be detected, the software shall automatically indicate that the data is no longer valid and identify the invalid data. The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data without any user programs or other actions to implement.
8. The system shall include a diagnostic program capable of running on-line or off-line that can monitor message rates from the communication program. The diagnostic will display the number of new messages, retries, time-outs, and any occurrences of error.
9. The system must support third-party objects and controls to be plugged in via OLE and Active X support.

10. Support of accessing data to and from the process database and historical archive to another (future) database using Structured Query Language (SQL) as a standard language.
11. Graphics Capabilities:
    a. Color object-oriented graphic displays for monitoring and controlling the process, which show the actual configuration of the process. Real-time values from various field devices shall be displayed in a variety of user-configurable formats. Displays shall be standard MS Windows files. Graphic screens shall be based on objects and not individual pixels.
    b. Interactive object-oriented editor or workspace that allows creation and editing of graphics using a mouse. Capability of making changes to the graphics without shutting down the system.
    c. Graphic screens that are opened in configuration mode must support tiling and cascading. Tiling must have horizontal and vertical support and no overlapping when the graphic screens are viewed.
    d. Size will be based on logical units; not pixels and any logical unit may be used. A design at one resolution must be able to run at a different resolution. Provide full screen option and the ability to add sizing borders to any graphic screen. Provide title bar enabled/disabled option.
    e. Support 256 colors. Color changes must be selectable from editing the individual foreground, background, or edge color property for each object.
    f. Provide configurable toolboxes that the user can customize as to what tools it contains and their position in the toolboxes. Provide a method to describe the function of each tool when the cursor is positioned on a particular tool.
    g. As a minimum, support the following object drawing tools: rectangle, square, rounded rectangle/square, oval/circle, straight line, polylines, polygons, arcs, chords, pie shapes, text.
    h. Operations that may be performed on objects or groups of objects must include: select/select all, deselect/deselect all, change color, move, nudge, cut, copy, paste, clear, duplicate, group/ungroup, align, space vertically/horizontally, grid, snap-to-grid, reshape, zoom in/out, send-to-back/bring-to-front, choice of line and fill styles, flip, search and replace tag names, undo, cursor position, rotation, space objects evenly, make objects same size, layers.
    i. Provide ability to dynamically update elements in the picture. Dynamic link elements shall include: data, time, date, system information, alarm summary, pushbutton, multi-pen chart, OLE objects.
    j. Multiple-pen chart link shall include: unlimited number of pens, display run time and historical data on same chart, configurable time span, configurable trend direction,

configurable zoom, scrolling grid, invert high and low limits, minimum of five line styles for pens, minimum of three prebuilt line makers and a customizable line marker.

k. Dynamic properties for objects must include: color changes (foreground, edge, background), fill percentage (horizontal, vertical), position/animation (horizontal, vertical, rotate, scale), script language (commands on down, up, mouse click, mouse double click, mouse move, edit), fill style (solid, hollow, horizontal, vertical, diagonal, cross hatch), edge style (solid, hollow, dash, dot, dash-dot, dash-dot-dot, null, inside frame. Provide capability to assign more than one dynamic property to an object.

l. For properties other than commands, configuration shall be by the mouse. Scripting or programming shall not be required. When building object dynamics, properties must support configuration from a dialog box, pop-up menu and user customizable dialog boxes or forms. Positioning property changes must support a method to get screen coordinates and automatically fill in the required coordinates for positioning. The user customizable dialog boxes or forms must be customizable through VBA. The system must supply the following pre-built forms: fill, rotate, position, scale, visibility, edge color, foreground color, background color, data entry, open/close picture, replace picture, open/close digital tag, toggle digital tag, acknowledge alarm.

m. The refresh rate shall be user-definable on a per object basis with the fastest being fifty milliseconds.

n. The animation of the graphics and objects shall be able to be linked to: Data acquired and stored by the system, data acquired and stored by a networked system, variables declared in the command language scripts, local and networked relational databases using SQL/ODBC.

o. Provide a wild card supported filter for assigning a data source. Provide a mathematical expression builder that is accessible from the graphic workspace.

p. Provide for easy reuse of graphic objects or groups of objects. The objects shall be intelligent Windows wizard-like objects. A library of objects shall be included: pipes, valves (manual and automatic types), pumps, motors, tanks.

q. The system must allow for bitmaps created by other systems to be imported into the graphics. Bitmaps must support a transparent mode and Metafiles must import as objects, not just bitmaps. As a minimum, the system must import .bmp, .msp, .jpg, wmf, pcx, ico, cur, psd, epr, and wpg.

r. MS Word and Excel documents must be able to live within a graphic screen, running with the graphic, not as an external call. Word and Excel toolbars must be inserted as part of the graphic toolbars.

s. Printing of graphic displays in color and black and white shall be supported via the standard MS Windows print manager in both the graphics development and runtime environments.

t. Operator entry methods shall be a flexible MS Windows NT method. Item selection and data entry shall be done with mouse or keyboard and the selected item shall be highlighted. The following data entry methods shall be supported: numeric, slider, pushbutton, ramp value, alphanumeric.

u. The system shall print a descriptive message with time stamp and user ID on the alarm printer or to an alarm file (as selected by user) whenever any of the following events occur: alarm, alarm acknowledgement, data entry into tag, reloading database file, saving database file, restarting the system.

v. The scripting language used by the system must be MS Visual Basic for Applications (VBA) or equivalent with one of the software packages specified. Scripts shall allow users to automate operator tasks, and create automations solutions. The scripting language must use MS IntelliSense feature, exposing all methods and properties of graphic objects. Editing will be with the Visual Basic Editor (VBE), which is part of VBA. Scripting language requirements include: animation of objects, automatic generation of objects, read write and create database blocks, automatically run other applications, incorporate custom security features, create custom prompts and messages, incorporate and communicate with third party and custom Active X controls, trap bad Active X controls, write custom wizards, scripts become part of the graphic screen, the VBE must allow import and export capability, there must be a link from the graphic editor to the VBE, VBA or VBE is launched from with in the system without any commands, all properties method and event of Graphic object created within the graphic editor of third party Active X controls used in the graphic screen must be exposed to VBA.

12. Alarms and Message Handling:

a. The system shall be capable of detecting alarm conditions based on the states and values of the various sensed variables whether or not the variables causing the alarms are on display. Alarm set points shall be enterable by the user upon configuration and during run time. Alarm types shall include: high high, high, low, low low, bad input from I/O, alarm disable, off scan, deadband, change of state, open, close. Support at least three priorities for each alarm type: high, medium, low.

b. Message enabling and disabling must be controlled at the block level. The system must be capable of sending messages based on the following events: an operator event occurs, process database event occurs. In addition to alarms, the following types of blocks must be able to generate messages that report to any transactions to and from the hardware: digital input, digital output, digital register, analog output, analog register, text.

c. The system must generate applications messages that describe database-related activity or operator entry. These messages shall be logged to alarm areas. Types of messages include: operator changes a process value, loads process database, logs into the system; any recipe upload, download or save condition; send information from a VBA script to all enabled alarm destinations; send a message from the database to all alarm destinations.

d. The system shall provide a means for placing an alarm message in one or more of the following locations: alarm summary display, alarm printer, alarm message file on disk, alarm history window.

e. Alarm messages shall be independently user-configurable as to what information is provided and its sequence within the message. The following shall be available choices: time of the alarm occurrence, name of tag causing the alarm, engineering units value, descriptor text assigned to the tag, engineering units of the tag.

f. When a new alarm condition is detected, an alarm message will be generated. If the alarm condition code text for the block is on the current display, then the text will flash until the alarm is acknowledged. Alarm acknowledgement will be performed from the keyboard or with the mouse and shall require no more than one keystroke or mouse click. The software shall include the following capabilities: alarm suspension which allows the user to specify digital tags that, when closed, cause alarms not to be generated for alarm conditions; re-alarm time which allows the system to re-generate an alarm after a user-configurable amount of time; alarm delay time which allows the user to specify a period of time for which an alarm condition must remain before an alarm is generated; close contact on alarm which allows user to specify digital tags that become closed when certain alarm conditions occur or reopened under certain conditions to allow operation of audible and visual alarms in the plant.

g. Provide an alarm summary display as a dynamic link within the graphics package. This must show a list of the pending alarms in the system. As new alarms are detected, entries are made to the display list. Placement of alarm information and color codes shall be configurable. Alarms can be acknowledged from the summary display either individually or for all alarms in the queue.

13. Archiving and Reporting:

a. Provide facility for automatically collecting, storing and recalling data. Recalled data shall be made available to a trend display program, a report generation program and to user-written programs.

b. Store data in Windows-compatible files in compressed format. Entries containing time, name, value and status will be made in the file whenever the real-time value exceeds the previously stored value by a user-supplied deadband limit. A deadband value of zero will cause an entry in the file each time the real-time value is examined. Files shall be organized according to time and will contain values for multiple, named variables. The files can be placed on the hard disk or floppy disk. Provide a mechanism for on-line maintenance and automatic purging of files.

c. The data to be collected by the archiving program will be identified through an interactive, menu-based configuration. The user will enter the tag name, collection rate, and data compression deadband value. Collection rates shall be selectable: 1 second, 2 seconds, 10 seconds, 20 seconds, 30 seconds, 1 minute, 2 minutes, 10 minutes.

d. The operator shall be able to recall archived data from the disk to be displayed in graphic format along with real-time data. The display of archived data shall be user-configurable. It shall be possible to configure objects in graphic displays that, when selected, fetch pre-defined historical trend data from disk and display it to the operator. Attributes of pens shall be editable during run-time.

e. The historical trend display shall be made up of the following components:

    1) Pen Group: Configuration shall be used to define the particular tag names to be displayed. Along with tag names, pen color, marker style and engineering units may be defined.

    2) Time Group: Configuration shall be used to define the time period over which the archived data is to be displayed.

    3) Legend Group: Configuration shall be used to define the legend parameters for a historical display. Both a primary and alternate legend may be displayed.

f. The display shall support unlimited variables to be displayed on the same time/value axis simultaneously. For each entry in the display list, the operator will be able to assign a given tag name and marker to a particular line color selected from palettes of unlimited colors. The operator may also enter display engineering units ranges to cause scaling of the display. Support shall be provided for multiple, different y-axis engineering units to be displayed as appropriate.

g. The display shall have two fields of view. The top portion of the screen shall be the graphic field and will display the values of the variables (y-axis) against time (x-axis). It will also contain labels for the axes and graphs. The bottom portion of the screen shall be user-configurable to display information, such as node-names, tag names, and descriptors, pertaining to the tags in the trend display.

h. The trend object shall allow for bi-directional trending and scrolling. A movable, vertical line will act as a time cursor on the display. The date, time and values of the trends corresponding to that time will be displayed in the bottom portion of the screen. The grid of the trend object shall be scrollable. The trend shall be shifted forward or backward in time by clicking on the right/left buttons. New data shall be fetched from the historical file as appropriate. The ability to display historical data with current data on the same chart must be supported. A transparent option for the trend must be selectable. The user shall be able to "zoom" on any section of the trend display by "cutting" that section with the mouse. The software will automatically re-scale both the y-axis and the time axis and will fetch the appropriate data for the time period selected. The trend object must have a refresh rate selectable in 0.1 second increments from a minimum of 0.10 seconds to a maximum of 1800 seconds.

i. The trend display shall be printable to a black and white or color printer via the standard MS Windows NT print manager.

14. Event Scheduling:
    a. The system shall support a scheduler with time-based printing of reports.
    b. The system shall allow for scheduling of the following time-based printing of reports: Hourly, shift, daily, monthly, yearly.
15. Security Management:
    a. Provide a user-based security system which, when enabled, must allow for the creation of users with certain rights and/or privileges. These rights must include the ability to run any combination or all of the applications in the data acquisition system. The ability to allow or disallow users access to change values, such as set points and control setups, on an individual tag basis shall be supported.
    b. Groups of users, such as operators or supervisors, can be created and granted rights. All users assigned to a group obtain the rights of the group although they are tracked by the system by their individual ID. Individual members of a group may be also assigned additional rights.
    c. The system must support a tie to Windows NT security. When user-based security is enabled, an audit trail will be generated in the system, which will tag every operator action with a user ID.
    d. The system must support at least twenty separate security areas, assignable on a per-tag basis. Each tag can be assigned all of the available security areas, none of the available security areas, or up to three individual security areas. Only users with clearance for those security areas shall have the ability to change parameters. Security area names may be up to twenty characters in length.
    e. The following functions must be supported: enable/disable user-based security; define users, passwords and login names; define groups to which users may belong; define security paths; define user and/or group rights/privileges; define security area names; define system auto-start user.
    f. The ability to lock an operator or other user into the runtime graphics environment shall be provided. Disabling any combination of the following shall be supported, as configured by the user: starting other applications; switching to other applications that

may be running; exiting from the system; restarting the computer using <Ctrl><Alt><Delete>; opening unauthorized screens; closing current screens; using the system menu; switching to the configuration environment; accessing the system tree.

g. The system shall allow for a login timeout setting for each user account. The system shall support manual login in and logout as well as automatic login. In addition, security information must be customizable through VBA scripting.

16. Services:

a. Training: A hands on tutorial shall be provided as part of the software to teach the basic operations of the system, including graphics and tag development. The tutorial shall demonstrate the configuration operations using interactive on-screen instructions. Standard classroom courses for operators of the system that cover the configuration and use of the system shall be available.

b. Customer Support: Programming staff shall provide 24/7 support via telephone and email. Field service by programmer, or programmer-trained distributor, shall be available on two-day notice.

c. Quality Assurance: The vendor must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software. The software shall have been in use by customers for at least three years.

17. Remote Operation of Controllers

a. Provide capability to operate controllers locally at the control and indicating stations and, except for burner management (flame safety) controls, remotely at the computer workstation. For safety, it shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation. The controllers include: master steam pressure, boiler/burner sub-master, burner fuel/combustion air, boiler draft, burner oxygen trim, boiler feedwater level, deaerator water level, condensate storage tank water level.

b. The operating personnel, when controllers are so enabled, shall have remote control of the following functions from the computer work station:

1) Select manual/automatic mode.
2) Set point (requiring use of high-level password).
3) Controller output when in manual mode.
4) Proportional/integral/derivative tuning parameters (requiring use of high-level password).
5) Controller analog output values.
6) Controller discrete output values.

c. The monitor display shall provide a facsimile of the controller front plates with clearly labeled English language and engineering unit display of the control parameters.

d. No special programming skills shall be required for any routine operating sequence.

18. Graphics: As a minimum, the following pictorial “screens” shall be available for observation:

a. Individual boilers with economizers (if provided) showing:

1) Main flame proven and approximate firing rate as shown by flame size depiction.

2) Steam output instantaneous flow rate (pressure compensated), lb/hr.

3) Steam output flow totalization (pressure compensated), lb. This is total production starting from time, day, month and year as set by operating personnel. Calculation shall be accomplished in control or instrumentation system, not in the SCADA software.

4) Steam header pressure, psi.

5) Boiler flue gas outlet temperature, °F.

6) Boiler flue gas oxygen percent. Set point of oxygen trim system (if trim provided).

7) Boiler flue gas outlet draft (if outlet draft control system is provided), inches WC.

8) Economizer flue gas outlet temperature, °F.

9) Economizer feedwater inlet temperature, °F.

10) Boiler feedwater inlet (economizer outlet) temperature, °F.

12) Signal to feedwater control valve.

13) Water level in boiler plus or minus inches from normal level.

14) Boiler plus economizer “Heat Loss” combustion efficiency not including radiation and unaccounted losses.

15) Fuel flow rate and totalization if individual boiler fuel meters are provided scfh. Totalization calculations shall be accomplished at the meters, not in the SCADA software.

16) Feedwater flow rate and totalization if boiler feedwater flow meters are provided gpm; gallons. Totalization calculations shall be accomplished at the meters, not in the SCADA software.

17) Trends of all flow, pressure and temperature data as listed above.

a. Boiler Plant:

1) Feedwater deaerator storage tank water level, inches of water.

2) Condensate storage tank water level, inches of water.

3) Pumps in operation.

4) Chemical feeders in operation.

5) Steam header pressure, psi.

6) Feedwater deaerator steam pressure, psi.

7) Boiler feed header pressure – each header, psi .

19. Specific Requirements – Historical Trending:
    a. Display No. 1 (one display per boiler): Individual boiler pressure-compensated steam flow rate, lb/hr; flue gas oxygen, percent; boiler stack temperature, F; economizer flue gas outlet temperature, °F; fuel flow rate, scfh
20. Specific Requirements – Alarm Monitoring and Operation Log:
    a. Alarm Monitoring Sequence:
        1) Alarm occurs:
            a) Monitor flashes alarm on all displays where point is shown.
            b) Display screen point or group flashes.
            c) Audible alarm sounds.
            d) Identification of alarm point is displayed at bottom of monitor screen.
            e) Printer logs alarm.
        2) Operator acknowledges alarm:
            a) Audible alarm is silenced.
            b) Alarm display stops flashing but remains highlighted.
        3) Point in alarm returns to normal after acknowledgment:
            a) Alarm display clears.
            b) Printer logs return to normal.
    b. Alarm Summary Display: The alarm sequence summary display shall alert the operator when points are in alarm. The time of occurrence, point identification, type of alarm, engineering value, and point description shall appear on the display. The most recent alarm shall be shown at the top of the display, with time of occurrence displayed in hours, minutes, and seconds.
    c. Operation Log: In addition to alarm conditions, this log shall also print status of pumps and burners (in service or out of service), status changes such as a transfer from auto to manual, set point change, etc., so that the resultant printout is a true and complete log of plant operations.
    d. Alarm points shall include:
        1) Burner management safety control system alarms.
        2) Boilers high and low water level.
        3) Boilers low flue gas oxygen.
        4) Boilers high stack opacity (if opacity monitors are provided).
        5) Condensate storage tank high and low water level.
        6) Feedwater deaerator high and low water level.
        7) Feedwater deaerator high and low steam pressure.
        8) High and low steam header pressure.
        9) Low feedwater pressure to each boiler.

10) Emergency gas valve closed.
11) High and low natural gas header pressure.
12) High and low fuel oil header pressure.
13) High and low fuel oil temperature (if heated oil is provided).
14) Propane igniter gas header pressurized (normal is zero pressure).
15) High and low oil level in each oil tank.
16) Oil tank and piping system leak detected.
17) Carbon monoxide (CO) or combustible gas in building.
18) Control system faults.
19) Medical gases.
20) Medical vacuum.
21) Emergency generator status.

21. Report Generation – Specific Requirements: The monitor shall display and the log sheet printer shall print out: instant, hourly, shift, daily and monthly plant operating reports. As a minimum, each report shall list:
    a. Maximum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
    b. Minimum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
    c. Totalization of steam produced, each boiler and combination of all boilers, lb.
    d. Totalization of steam used in boiler plant, lb.
    e. Totalization of oil consumed, gallons.
    f. Totalization of natural gas consumed, mscf.
    g. Totalization of feedwater consumed, each boiler, gallons.
    h. Make-up water used, gallons.
    i. Make-up water as a percent of total steam production of all boilers combined.
    j. Number of heating degree-days.
    k. Hours of operation of each boiler.
22. Communication with Burner Management (Flame Safeguard) Control Systems: Provide means to communicate with each burner safety control system to determine status, operating hours, flame signal strength, history of lockouts, number of short circuit events, other data necessary for remote trouble-shooting.
23. Monitor Screen Printout: Any display on the screen shall be able to be printed as required to provide hard-copy record.

D. Sensors and Transmitters: Provide as necessary to satisfy programming requirements. Refer to Articles, PRESSURE SENSORS AND TRANSMITTERS, and TEMPERATURE SENSORS AND TRANSMITTERS.

2.6 FLUE GAS OXYGEN ANALYZERS:

A. Oxygen content of flue gases of each boiler measured by zirconium-oxide in-situ systems with probe mounted in stack or breeching. Output to boiler/burner submaster controller for oxygen trim. Single range, 0 to 10 percent oxygen.

B. Performance:

1. Minimum accuracy of plus or minus 2 percent of reading.
2. Speed of response eight seconds or less to 90 percent accurate reading.
3. Resolution 0.1 percent oxygen.
4. These performance requirements are minimums and must be increased if necessary to suit the requirements of the oxygen trim system (if provided).

C. Field-replaceable cell, heater, and cell temperature sensor. Project Engineer has the option of accepting long-term guarantee of unit exchange at favorable cost in lieu of capability of field-replacement of components.

D. Reference and Calibration Air (if required by units furnished):
Provide refrigerated air dryer and instrument quality compressed air supply to each unit. Coalescing color-change filter and pressure regulator at each analyzer.

E. Automatic Calibration System: In-stack using bottled calibration gas mixtures containing oxygen and nitrogen. Number of mixtures and composition as recommended by analyzer manufacturer. See Article, TOOLS.

1. Selectable manual/automatic calibration, which will operate at preprogrammed intervals and upon power-up.
2. Calibration gas piping system with permanently installed stop valves, pressure and flow regulators, pressure gages, and flow meters to permit connection of gas bottles to unit. Locate all gas bottle connections, regulators, gages and valves accessible from floor without use of ladders.

F. Analyzer Displays: Operating parameters, process and diagnostic data, including percent oxygen, cell temperature, and set points of alarms and burner cutouts.

G. Analyzer Outputs:

1. Modbus communications and analog output compatible with boiler/burner submaster controller for flue gas oxygen trim the boiler operation recorders the computer workstation.
2. Low flue gas oxygen alarm on main panel annunciator. Set point adjustable 0.5 to 3.0 percent oxygen. Interface with burner management system to provide low oxygen shutdown of burner. Set point adjustable 0.5 to 3.0 percent oxygen. Set points shall not be adjustable from the front of the panel. Refer to Paragraph, BURNER MANAGEMENT SYSTEMS WITH SAFETY INTERLOCKS AND ACCESSORIES.

2.7 FLOW METERS:

A. Vortex Flow Meters with Transmitters:

1. Provide vortex-shedding flow meters designed for accurate measurement of flow rate ranges shown at required pressures. Minimum turndown capability shall be as scheduled. Meters shall have digital readout of pressure-compensated flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to computer workstation. As an option, pressure compensation and the compensated flow rate may be performed and displayed by a boiler plant controller receiving signals from the flow meter and from a pressure transmitter. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
2. Programmable microprocessor electronics with on-board programming. Output signals immune to ambient temperature swings. Continuous self-diagnostic routines that identify electronics problems and provide a warning. Electronics replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics separate from meter body in position accessible from platform or floor without the use of a portable ladder.
3. All welded wafer-type or flanged stainless steel meter body with no seals. No sensor parts exposed to the flow stream. Provide alignment rings with wafer-type meters to assure proper centering in the pipeline. Trapezoidal shedder bar, sensing by detecting stresses in the shedder bar caused by vortices, dual piezoelectric crystals located outside the process flow sense the shed vortices, dual crystal alignment cancels effects of noise and vibration. Designed for Schedule 40 piping.
4. Transmitted signal accuracy plus or minus 1.5% of flow rate. Repeatability 0.2% of actual flow rate. Meter designed to minimize vibration effect and to provide elimination of this effect.

B. Water Flow Meters:

1. Type: Continuous duty positive displacement disk or turbine type with meter-mounted totalizing registers.
2. Service: Provide individual meters to measure volume of cold water, soft water as shown.
3. Performance: Conform to scheduled flow range, accuracy, maximum pressure drop, maximum static pressure and temperature for the liquid shown. Minimum accuracy plus or minus 0.5% of flowrate over 4/1 turndown.
4. Meter Construction:
    a. Bronze or iron cases, threaded pipe connections, designed for 1025 kPa (150 psi) maximum pressure.
    b. Registers: Hermetically sealed, magnetic coupling, digital flow rate readout or sweep hand registering one or ten gallons per revolution and digital register for totalizer with at least five digits. Provide horizontal register box with gasketed viewing glass and hinged cover. Register shall have capability of being positioned to any of the four cardinal points

for readability. Provide remote flow indication on main instrument panel with flow rate and totalization. Transmit flow data to computer work station.

C. Fuel Oil Meters:
   1. Type: Positive displacement screw type, cast iron cases, nitrided steel spindles, seals, threaded pipe connections, designed for pressure exceeding set pressure, plus 25 percent, of nearest upstream relief valve. Rated for 120 degrees C (250 degrees F) if utilized for heated oil. Accuracy plus or minus 0.1% of flow rate over required flow range.
   2. 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 remote flow rate and totalization readout device. Transmit flow data to computer workstation.
D. Turbine-Type Natural Gas Flow Meters:
   1. Type: Turbine-type with volume totalizing digital readout that is continuously updated and corrected for the line pressure and temperature. Meter readouts shall be located on meter and in computer workstation and on main instrument panel. Meter shall be designed for natural gas at job site characteristics.
   2. Performance: Maximum flow rate as scheduled. Pressure drop shall not exceed 1.25 kPa (5 inches WC). Accurate flow minimum turndown range shall be 20/1 with minimum accuracy one percent of flow rate over the entire range.
   3. Construction:
      a. Meter: Design for 850 kPa (125 psi). Pipe connections flanged 850 or 1025 kPa (125 or 150 psi) ANSI. All bearings and gearing shall be in areas sealed from contaminants. Metering transducers operated through magnetic coupling. The measuring devices shall be contained within a module that can be removed from the meter body for service and calibration without breaking the main gas piping connections. Corrosion-resistant material of construction or coating.
      b. Indication Devices on Meter: Electronic type which provides a totalized continuous volume flow digital indication in cubic feet automatically continuously corrected to the local contract base temperature and pressure from actual varying line temperatures and pressures. Unit shall also display a totalized uncorrected volume flow indication. The display shall show actual line temperature and pressure at the meter and pressure-temperature correction factor. Smallest corrected flow indication shall be one thousand cubic feet, and indicator shall have at least six digits. Unit shall be watertight where drawings show an outdoor location.
   4. Calibration: Factory calibrated. Furnish three-point curve spanning required flow range on actual meter furnished.

5. Accessories:
   a. Remote Digital Register: Provide a remote digital register system including pulse generator and all wiring and accessories for proper functioning. Remote register shall have a digital cubic feet volume readout corrected to the local contract base temperature and pressure from actual varying line conditions. Smallest indication shall be one thousand cubic feet and indicator shall have at least six digits. Provide 120-volt power supply from panel. Main plant register shall be located on main instrument panel; individual boiler registers shall be located on boiler control panels.
   b. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.
   c. Filter: Shall have replaceable glass-fiber or cellulose cartridge with ten micron or smaller particle retention. Filter enclosure shall be the pipe size of the meter or larger as required by pressure drop considerations. Static pressure capability shall be at least twice lockup pressure of service supply regulators. Maximum pressure loss 1.25 kPa (5 inches WC) at maximum design flow rate of meter. Plug all drains or instrumentation outlets. Provide vent with cock for relieving pressure in filter.

2.8 BOILER STACK OPACITY MONITORS:

A. Provide complete microprocessor-controlled system for each boiler with sensor mounted on boiler stack or breeching, separate control unit mounted in accessible location, and panel-mounted display. Electronics shall have RS485 Modbus communications and an analog output for input to the combustion control panel and transmittal to the computer workstation. Electronics shall have automatic and manual calibration via the front panel of the opacity monitor.

B. Light source shall have life expectancy greater than one year. System shall automatically compensate for lamp aging and voltage variations.

C. Provide panel-mounted display which shows the opacity and alarm and maintenance functions. These alarms and functions shall include:
   1. Pre-emission.
   2. Over-emission.
   3. Lamp out.
   4. Purge blower failure.

D. Provide alarm bell on front panel, with silencing control, to sound when over-emissions or other alarm condition occurs.

E. Mount control panel on the panel that includes the combustion controllers.

F. Purge air system with blower, provided by manufacturer of opacity monitor, to reduce build-up of dirt on lenses. System shall include disposable air filters.

G. Printer: Provide strip chart opacity recorder with date and time stamp. Connect to opacity monitor output.

H. Spare Parts Required:

1. Lamp for opacity monitor.
2. Six air filters for opacity monitor air purge unit.
3. Three months supply of chart paper for strip chart opacity recorder.

2.9 PRESSURE SENSORS AND TRANSMITTERS:

A. Transmitters for gage pressure, differential pressure, fluid level, and draft utilized for instrumentation, computer workstation, and controls.

B. “Smart” programmable electronics, sealed diaphragms, direct-sensing electronics, no mechanical force or torque transfer devices, non-interactive external span and zero adjustment, solid-state plug-in circuit boards. Minimum accuracy plus or minus 0.1 percent of calibrated span. 40:1 minimum rangeability. Communication system shall be compatible with boiler plant controls and instrumentation.

C. Shut-off and blowdown valves on all transmitters. Equalizing/calibration manifold valves on all differential pressure and fluid level transmitters. Connection points to permit calibration of system with a portable pressure calibrator.

D. Reservoirs for transmitter piping connections where an interface between liquid and steam is present, such as boiler water level sensing and differential pressure steam flow meter applications.

E. Provide and deliver to Project Engineer (RE) all hardware and software necessary for field calibrating and programming all transmitters.

F. Spare Parts: One transmitter of each type utilized in the project.

2.10 BOILER DRAFT GAGES:

A. For D-type water tube boilers, provide gages for windbox, furnace, boiler outlet, and economizer (if provided) outlet. For flex-tube water tube boilers and for fire tube boilers, provide gages for boiler outlet and economizer (if provided) outlet.

B. Type: Analog, multiple vertical scale, dry diaphragm, balanced pointers, semi-flush-mounted, zero adjustment.

C. Scales: Internally illuminated, minimum length 120 mm (5 inches), scale ranges coordinated with equipment furnished and actual operating conditions, scales labeled for the service. If, in operation, indicators go under-range or over-range, the gages shall be replaced with greater ranges, at no additional cost to the Government. Scales for furnace, boiler outlet, and economizer outlet gages must be combination negative and positive pressure.

D. 3-way cock for each gage to permit shut-off, connection to service, connection to atmosphere.

E. Mount on boiler/burner control panel.

2.11 TEMPERATURE SENSORS AND TRANSMITTERS:

A. Provide resistance temperature detectors (RTD).

B. Provide transmitters or panel-mounted indicator transmitters, transducers, and receivers compatible with the system including the controllers C. Minimum accuracy one percent of actual temperature.

D. Boiler and economizer flue gas temperature sensors shall be averaging type and shall extend across width of stack or breeching.

E. Provide stainless steel weather hood on outside air temperature sensor, which shields the sensor from direct sunlight.

2.12 RECORDERS:

A. Provide complete systems to continuously receive and record steam flow, fluid temperatures, fluid pressures and boiler flue gas oxygen percent. System shall also include steam flow totalizing functions.

B. Identification: Provide engraved plastic or metal plate at each recorder which lists recording and totalizing ranges, units of measurement, multiplying factors, steam flow transmitter differential pressure, steam flow primary element identification data such as steam pressure upon which primary element size was calculated, chart identification number.

C. Electronic Display-Type Paperless Recorder:

1. Microprocessor-based programmable signal receiving, recording and display. Configure through touchscreen or front keypad. Waterproof and dustproof front panel.
2. Display: 250 mm (10 inch) minimum height and width, XGA 16 bit color with 125 ms trend speed or TFD color LCD. 24 colors minimum.
3. User-editable custom screens.
4. Input channels: Quantity sufficient for requirements stated below or shown on drawings. Each recorder shall be limited to data from two boilers.
5. Minimum of 16 simultaneous real time trending displays shown as selectable trace, bargraph and digital values and identified as to function with scale values, engineering units.
6. Totalizers for all flow functions.
7. Under/over range signal and alarm displays and high and low alarm displays for each input.
8. 32 Mbyte internal flash memory.
9. Standard Ethernet communications – 1/100baseT. Modbus protocol.
10. USB plug and play capability to allow remote connection to perform any operation that can be done directly on the instrument.
11. Recording destinations:
    a. Data backup static minimum 36 Mbyte RAM.
    b. Automatically download data directly to in-plant computer workstation hard drive. Provide and install software compatible with workstation operating system.
    c. USB Memory Stick removable media.
12. Password protection of parameters. Provide passwords to Project Engineer (RE).

D. Recording Functions:

1. Steam Flow:

   a. Record steam flow rate and totalize steam flow from: each boiler individually, individual steam distribution lines, in-plant uses.

   b. Provide continuous totalizer for each flow function. Counter shall have six digits minimum.

   c. Pressure Compensation: Provide system that automatically corrects the steam flow recording and totalization for the actual line pressure. Boiler and distribution steam flow recorders may utilize the main header pressure as the signal for pressure correction if there are no intervening pressure regulators. On boilers with two-element or three-element feedwater level control, provide pressure compensated flow signal to the feedwater level controller.

2. Boiler Flue Gas Oxygen, Stack Temperature, Steam Header Pressure, Outside Air Temperature, Feedwater Temperature.

3. Provide all new sensors and transmitters for each recorder input.

4. All data shall be available via Modbus communications for the computer workstation (present or future workstation).

2.13 GAGES, PRESSURE AND COMPOUND, PIPE OR TANK-MOUNTED:

A. Construction:

1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.

2. Dial: Non-corrosive, 110 mm (4-1/2 inch) diameter face with black markings on white background.

3. Measuring Element: Bourdon tube designed for the required service. Provide bellows designed for service for pressure ranges under 100 kPa (15 psi).

4. Movement: Stainless steel, rotary.

5. Pointer: Micrometer adjustable, black color.

6. Window: Plastic.

7. Liquid Filled Gages: Provide at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners where bourdon tube gages are utilized. Gage filling shall be glycerin or silicone oil. Purpose of filling is to provide pulsation dampening. As an option to liquid filling, provide dry gages that have built-in fluid clutch dampeners that are not vulnerable to plugging due to foreign material.

B. Accuracy: ASME B40.100, Grade 2A, ½ percent, on all gages; except Grade A, one percent permitted on diaphragm actuated gages, liquid filled gages, and compound gages.

C. Accessories:

1. Red set hands on gages located at automatic pressure regulator valve outlets.
2. Needle valve or gage cock rated for the service.
3. Syphon on all steam gages.
4. Pulsation snubbers on diaphragm-type gages located adjacent to gas burners.

D. Scale Ranges: Provide dual English/metric scales:

1. Low pressure steam to 100 kPa (15 psi): 0 to 200 kPa/0 to 30 psi.
2. Medium pressure steam to 407 kPa (59 psi): 0 to 700 kPa/0 to 100 psi.
3. High pressure steam above 407 kPa (59 psi): 0 to 1400 kPa 0 to 200 psi.
4. Natural and LP gas: 0 to 200 kPa/0 to 30 psi.
5. LP gas at tanks: 0 to 2100 kPa/0 to 300 psi.
6. Gas burner, 125 percent of full load pressure, kPa/inches WC.
7. Oil pump suction: 100 kPa vacuum to 100 kPa/30 inches Hg vacuum to 15 psi.
8. Oil pump discharge: 0 to 1400 kPa/0 to 200 psi.
9. Oil burner, 125 percent of full load pressure, kPa/psi.
10. Compressed air, 345 kPa & higher (50 psi & higher): 0 to 1100 kPa/0 to 160 psi.
11. Feedwater pump discharge: 0 to 2100 kPa/0 to 300 psi.
12. Feedwater pump suction: 100 kPa vacuum to 200 kPa/30 inches Hg vacuum to 30 psi.
13. Pumped condensate: 0 to 400 kPa/0 to 60 psi.
14. Condensate transfer pump discharge: 0 to 400 kPa/0 to 60 psi.
15. Condensate transfer pump suction: 100 kPa vacuum to 100 kPa/30 inches Hg vacuum to 15 psi.
16. Feedwater deaerator: 100 kPa vacuum to 200 kPa/30 inches Hg vacuum to 30 psi.
17. Other services, 200 percent of maximum operating pressure.

E. Boiler Steam Pressure Gages: Refer to Section 23 52 33, WATER-TUBE BOILERS.

F. Panel-mounted Gages: Refer to Article, MAIN INSTRUMENTATION AND CONTROL PANEL.

2.14 THERMOMETERS, PIPE OR TANK-MOUNTED:

A. General: Thermometer locations are shown on the drawings.

B. Construction:

1. Industrial type, separable well and socket, union connected.
2. Scales: Red reading mercury combination 30 to 300 degrees Fahrenheit/0 to 150 degrees Celsius scales, unless otherwise shown. Scale length 220 mm (9 inch) except 170 mm (7 inch) scale length acceptable on oil burner piping. Mercury sealed under pressure with inert gas to prevent oxidation and separation of column.
3. Case: Corrosion resistant with glass or plastic front.
4. Form: Straight or back form except thermometers located more than 2100 mm (7 feet) above floor or platform shall be adjustable angle.

5. Wells: Sized to suit pipe diameter without restricting flow. Provide snug sliding fit between socket and well.
6. Accuracy: One percent of scale range.

2.15 BOILER PLANT BUILDING DANGEROUS GAS DETECTION SYSTEM; CARBON MONOXIDE AND COMBUSTIBLE GAS:

A. Automatic microprocessor-based industrial-class system that monitors the concentration levels of carbon monoxide and combustible gases in the boiler room and associated spaces. The system shall include displays of the concentration levels of the gases detected by each sensor and provide audible and visual alarms when these gases are detected. Control/transmitter panels with displays and control functions shall be located 1500 mm (5 feet) above the boiler room floor. Provide 2 combustibles sensors and 6 carbon monoxide sensors at locations shown or as directed. Provide RS485 Modbus communications protocol (i.e. Modbus RTU, etc.) of detected gas concentration levels and alarms to computer workstation and central control panel. Transmit alarm signal to designated location outside the boiler plant:___An_________________ Audible and visual alarm shall be provided at this location.

B. System Description:

1. Carbon Monoxide (CO) Sensors: Transportable calibration, electrochemical plug-in type, range 0-100 ppm, detection limit less than plus or minus 5% of full scale, response time less than 10 seconds, zero drift less than 5% per year, span drift less than 10% per year, repeatability less than plus or minus 5% of full scale, active temperature compensation. Set point: 25 - 50 ppm.
2. Combustible Gas Sensors: Plug-in type, infrared detection, no moving parts, range 0-100% lower explosive limit. On-board storage of calibration data, peak values, time and date stamped. Set point: 10% of lower explosive limit.
3. Controller/Transmitters: Separate from sensors, non-intrusive calibration. NEMA 4 enclosure, sensors connected to transmitter with easily operated connection devices. Universal transmitter which can accept infrared, catalytic bead, or toxic sensor and auto-configure when sensor connector is inserted. LED display of gas type and concentration, alarm horn and strobe, output compatible for computer work station, integral non-volatile memory, automatic resume on power failure, sensor and controller diagnostics, menu-driven calibration. Networked with computer work station SCADA program or central control panel via RS-485 four-wire bus, such as Modbus RTU.
4. Additional Features:
   a. Capability to remotely mount sensor from transmitter to allow calibration at convenient point up to 100 feet away.
   b. Sensor/transmitter display shall indicate all diagnostic check/fault conditions with detailed message displays.

c. Full-function keypad or magnetic touch points to allow setting alarm set points, change span gas values and display date of last calibration.

5. Calibration: Sensor/transmitters shall be calibrated with hand-held calibration devices furnished by system manufacturer. Provide complete calibration kit, including test gases, for commissioning and future calibrations. Provide permanently mounted hose for remote-mounted sensors.
6. Approvals: NEC and CEC for explosion proof or non-incendive, when required.
7. Product Support: Supplier shall have organization, located within 150 miles of site, with capability of complete on-site product
8. Power Supply: Provide protected power supply to protect system from surges, spikes, transients, overloads in the incoming power supply.

2.16 TOOLS:

A. Portable Deadweight-Type Pressure Gage Tester:
1. Type: Portable hydraulic deadweight tester with minimum range of 10 to 300 psi.
2. Accuracy: Within plus or minus 0.1 percent of indicated pressure traceable to National Institute of Standards and Technology (NIST).
3. Construction: Steel or aluminum carrying case, compact design unit with weights and pump fitting within one carrying case, weights replaceable without replacing remainder of apparatus.
4. Accessories: Gage pointer puller, 6 mm (1/4 inch) and 12 mm (1/2 inch FNPT) pressure gage connectors, sufficient hydraulic fluid to fill tester three times, all tools recommended by manufacturer.
5. Delivery: Deliver to Project Engineer (RE) for use by VA personnel only. Deliver prior to boiler tests.

B. Portable Digital-Type Pressure Gage Tester:
1. Type: Portable digital pressure calibrator with a minimum range of 10 to 200 psi.
2. Accuracy: Within plus or minus 0.04% of indicated pressure traceable to National Institute of Standards and Technology (NIST).
3. Construction: Steel or aluminum carrying case, compact design unit with hand pump, fittings for connecting to pressure gages and pump, test leads.
4. Accessories: Gage pointer puller, 6 mm (1/4 inch) and 12 mm (1/2 inch FNPT) pressure gage connectors, all tools recommended by manufacturer for testing pressure gages.
5. Delivery: Deliver to Project Engineer (RE) for use by VA personnel only. Deliver prior to boiler tests.

C. Calibration Gases for Boiler Flue Gas Oxygen Analyzers and Building Carbon Monoxide and Combustible Gas Detection System:

1. Type: Compressed gases in transportable cylinders, certified analyses. One cylinder of each mixture for each analyzer. Composition of mixtures and quantity of mixtures as recommended in written instructions by analyzer and gas detection system manufacturers.
2. Cylinders: Minimum capacity 100 liters of gas, approx. 75 x 360 mm (3 x 14 inch) cylinder.
3. Delivery: Deliver to Project Engineer prior to initial calibration of instrumentation. Contractor personnel may use gases. Provide new full cylinders, to replace gases used during start-up and testing after boiler plant testing is complete.

D. Communication Devices for Programming Instrumentation and Controls:
Furnish all devices necessary to configure all programs and obtain all data from instruments and controls. Deliver to Project Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORK STATION (IF PROVIDED):

A. General:

1. Nameplates, Labels and Identification: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
2. Electrical Work and Safety Requirements: Comply with NFPA 70 and referenced electrical sections of these specifications.
3. Electrical Wiring: Comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS; Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS; Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW); and Section 26 27 26, WIRING DEVICES. The term "wiring" includes furnishing of wire, conduit, miscellaneous material and labor to install a complete working system as specified.
4. All devices plumbing and wiring shall comply with and be arranged as shown in the most recent edition of the “VHA Boiler Plant Safety Device Testing Manual”.
5. Protect all circuits to avoid interruption of service or damage to equipment due to short-circuiting or other conditions. Line-protect from lightning and static electricity all wiring that comes from external sources.
6. Except for short apparatus connections, run conduit and pneumatic tubing parallel to or at right angles to the building structure.
7. Run tubing and wire connecting devices in control cabinets parallel with the sides of the cabinets neatly racked to permit tracing. Rack wiring bridging a cabinet door along the hinge side and protect from damage. Provide grommets, sleeves or vinyl tape to protect plastic tubing or wires from sharp edges of panels, conduit, and other items. Fit all equipment contained in cabinets or panels with service loops; each loop shall be at least 300 mm (12

inches) long. Equipment for fiber optic systems shall be self-supporting, code gage steel enclosure.

8. Permanently mark terminal blocks for identification. Label or code each wire at each end. 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. Cables:
    a. Keep cable runs as short as possible. Allow extra length for connecting to the terminal board.
    b. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
    c. Cables shall be supported for minimum sag.
    d. Splices in shielded and coaxial cables shall consist of terminations and shielded cable couplers. Terminations shall be in accessible location. Cables shall be harnessed with cable ties.

B. Pressure, Temperature, Level and Flow Transmitters: Mount in locations accessible from floor or platform without use of portable ladders. Provide separate conduit for each transmitter signal if recommended by manufacturer. Protect sensor or controller on steam or water service by an adequate water seal at all times and provide blowdown facilities to permit blowdown of sensing lines. Install temperature sensors with entire temperature sensing surface immersed in media being measured. Locate outside air temperature sensor on north side of building away from heat sources. Provide isolation valves on all transmitters connected to fluid systems. Locate isolation valves so that transmitter can be isolated while main sensing line is being blown down. Provide equalizing valves on all differential pressure transmitters. Provide valved drains on all fluid lines. Valves shall be rated for minimum of 150 percent of system pressure and temperature.

C. Steam Flow Meter Primary Elements (In-Line Flow Sensors) including Vortex-Shedding Type: Provide straight runs of piping upstream and downstream as recommended by manufacturer to achieve maximum accuracy and rangeability. Verify that stresses in piping system do not exceed allowable stress of flow meter body. Locate meter electronics including read-out devices accessible from floor or platform without the use of portable ladders.

D. Flue Gas Oxygen Analyzers:
1. Mounting: Provide freestanding floor-mounted steel rack for mounting control panels and read-outs. Position panels and readouts 1500 mm (5 feet) above the boiler room floor.
2. Sampling point shall be upstream of smoke density monitor in non-turbulent area. Locate probe within 4.5 meters (15 feet) of floor or accessible from platform.
3. Reference Air: Provide dry, filtered, pressure-regulated compressed air service to each unit. Provide isolating valve at each unit.

4. Calibration Gases: Provide permanently installed valved piping connections, pressure regulators and gages in flue gas sampling system for connection of required calibration gases. Locate within 1200 mm (4 feet) of main floor.
5. Interconnection of Instruments: Provide shielded wiring as recommended by instrument manufacturer.
6. Power Circuits: Provide dedicated circuits from a plant panel. Analyzers shall remain powered when burner control is off.

E. Wiring and Piping: Is generally not shown on the drawings. All wiring and piping must be provided in accordance with NFPA 70 and ASME B31.1.

F. Combustion Control Linkage Systems: After completion of burner adjustments, counter sink all lever set screws into shafts or pin levers to shafts to prevent levers from slipping on the shafts.

G. Boiler Stack Opacity Monitors (if provided): Locate downstream from oxygen sensing systems so that opacity monitor air purge does not affect flue gas oxygen reading. Locate sensor within 4.5 m (15 feet) of floor or accessible from platform without use of portable ladder. Locate air purge blower unit within 2400 mm (eight feet) of floor or accessible from platform without use of portable ladder.

H. Compressed Air Filters: Pipe drain to nearest floor drain.

3.2 INSTALLATION, NATURAL GAS FLOW METERS:

Entire installation shall conform to recommendations of the meter manufacturer for obtaining the most accurate flow measurements. Arrange meter readout so that it is visible from nearest walkway or service platform.

3.3 INSTALLATION, PRESSURE GAGES:

Orient gages so that dials are upright and visible from the nearest walkway or access platform. Install gages with gage cocks. Provide pig-tail syphons on steam service. Provide compound gages on all pump suction lines and on feedwater deaerator; provide pressure gages elsewhere. Install liquid-filled or equivalent (as specified) gages at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners. If diaphragm-type gages are used, provide pulsation dampeners instead of liquid-filling.

3.4 INSTALLATION, THERMOMETERS:

Arrange thermometers so that scales are upright and visible from nearest walkway or access platform. Provide adjustable angle thermometers on applications more than 2100 mm (7 feet) above floor or platform. Tilt the angle type thermometers for proper view from floor or platform. Locate wells in flow stream.

3.5 INSTALLATION-WATER AND OIL FLOWMETERS:

Provide strainer upstream with 80-mesh screen liner. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS. Position register for upright viewing from nearest walkway.

3.6 TESTING, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORKSTATION:

A. Representatives of the designer of the system shall demonstrate proper operation and calibration of all components, computer programs, and entire systems to the Project Engineer (RE). If the project includes boiler/burner testing, the demonstration involving boiler/burner data shall be conducted during the boiler/burner tests. Furnish personnel, instrumentation, and equipment necessary to perform calibration and testing. All calibration work must be completed prior to the testing.

B. Burner Management (Safety Control) Systems: All test shall be based on the most recent edition of the “VHA Boiler Plant Safety Device Testing Manual”, also Refer to Section 23 52 33, WATER-TUBE BOILERS.

C. Steam Flow Measuring: Demonstrate proper calibration of each flow rate signal and indication and each totalizer signal and indication to Project Engineer or their representative prior to the start of the final boiler testing.

D. Pressure test all pneumatic control tubing at one and one-half times the normal operating pressure.

E. Testing shall demonstrate proper calibration of input and output devices, the proper operation of all equipment, proper execution of the sequence of operation, proper tuning of control loops and maintaining of all set points.

F. Document all tests with detailed report of test results. Explain in detail the nature of each failure and corrective action taken.

G. During and after completion of the pretests, and again after the final acceptance tests, identify, determine causes, replace, repair and calibrate equipment that fails to comply with contract requirements or the standards of the manufacturer. Provide written report to Project Engineer.

H. Demonstrate safety and operating interlocks.

I. Demonstrate that programming is not lost and that the control and instrumentation system performs the correct sequence of control and instrument functions after a loss of power.

J. Furnish to Project Engineer graphed trends of control loops to demonstrate that the control loops are stable and that set points are maintained. Trend data shall be instantaneous and the time between data points shall not be greater than one minute.

K. Signal Transmission System Equipment:

    1. Ground Rod Tests: Before any wire is connected to the ground rods, use a portable ground testing instrument to test each ground or group of grounds.

    2. Coaxial Cable Tests: Implement NEMA WC 63.2 as a minimum.

L. Computer Workstation Software Operation Test:

    1. Test ability to properly communicate with and operate the control systems.

    2. Demonstrate the ability to edit the programs off and on line.

    3. Demonstrate operation of all alarm points.

4. Demonstrate the receipt, display, and saving of trend and status reports.
5. Demonstrate display and operation of all graphics.
6. Demonstrate all program calculating functions and report generation.
7. Demonstrate proper operation of all printers.

3.7 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 Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.9 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 – GENERAL

1.1 DESCRIPTION

A. The control system(s) shall be as indicated on the project documents, point list, drawings and described in these specifications. This scope of work shall include a complete and working system including all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.

B. Engineering Control Center (ECC) shall include:

1. Operator Workstation Web-Browser User Interface (UI).
2. Ethernet, IP Supervisory Network.
3. Portable Laptop servicing device with software.
4. Graphic Operational Interface.
5. Software Configuration Tools (SCT).
6. Scheduling and Alarm Management software.
7. Local BACnet MSTP or IP networks.
8. Network Area Controllers (NAC).
9. Data and File Server (DFS).
10. Unitary Control Units (UCU).
11. BACnet compliant application controllers and field devices.
12. Connected I/O devices.
13. Third party system Data Integration.

C. The Controls Contractor’s work 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 by the Contract for the complete and fully functional Controls Systems.

D. Following control devices and systems shall be used to provide the functional requirements of HVAC equipment and systems.

1. Direct Digital Control (DDC) of HVAC equipment and systems with electric or electronic positioning of valves and dampers.
2. Terminal units including VAV Boxes, Fan Coil Units, 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.

E. Base bid includes the installation of new DDC controls as well as electronic operators as indicated on the temperature control diagrams and the I/O Points List.

F. The control subcontractor shall supply as required, all necessary hardware equipment and software packages to interface between any existing and new system Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices, hardware and software points provided. Network area controllers are same as remote controller units (RCU).

G. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. Temperature Controls contractor 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.

H. The Top End of the NAC shall communicate using American Society of Heating and Refrigerating Engineers/American National Standards Institute (ASHRAE/ANSI) Standard 135(BACnet) protocol. The NAC shall reside on the BACnet/IP Ethernet (ISO 8802-3) local area network, and provide information via standard BACnet object types and application services. The Bottom End of the NAC, the unit level controllers and all other field devices shall reside on the BACnet MSTP network.

I. The control system shall accommodate ~~5~~ users simultaneously, and the access to the system should be limited only by operator password.

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J. 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	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/boiler controls	23 09 23	23 09 23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Water treatment system	23	23	23	26
VFDs	23	26	23 09 23	26
Control system monitoring of fire alarm smoke control relay	28	28	23 09 23	28
Fan Coil Unit controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Starters, HOA switches	23	23	N/A	26

1.2 RELATED WORK

A. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

B. Section 28 31 00, FIRE DETECTION AND ALARM.

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

D. Section 21 10 00, WATER-BASED FIRE-SUPPRESSION SYSTEMS.

E. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

F. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

G. Section 23 36 00, AIR TERMINAL UNITS.

H. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

I. Section 23 81 43, AIR SOURCE UNITARY HEAT PUMPS

J. Section 23 31 00, HVAC DUCTS AND CASINGS.

K. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

M. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

N. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

O. Section 26 27 26, WIRING DEVICES.

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. ACU: Auxiliary Control Unit (ACU) used for controls of air handling units, reports to RCU.

C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.

D. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.

E. 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).

F. 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.

G. 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.

H. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.

I. 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. In this specification, there are three types of control units are used; Unitary Control Unit (UCU), Auxiliary Control Unit (ACU), and Remote Control Unit (RCU).

J. 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).

K. 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.

L. 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.

M. 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.

N. 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.

O. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.

P. 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.

Q. 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.

R. 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.

S. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.

T. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.

U. FTT-10: Echelon Transmitter-Free Topology Transceiver.

V. GIF: Abbreviation of Graphic interchange format.

W. 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.

X. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

Y. 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.

Z. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.

AA. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.

BB. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.

CC. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.

DD. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a “Neuron Chip” for communication.

EE. LonWorks: Network technology developed by the Echelon Corporation.

FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.

GG. Network Area Controller: Digital controller, supports a family of auxiliary control units and unitary control units, and communicates with peer-to-peer network for transmission of global data.

HH. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.

II. MS/TP: Master-slave/token-passing.

JJ. Operating system (OS): Software, which controls the execution of computer application programs.

KK. 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.

LL. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.

MM. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.

NN. PICS: Protocol Implementation Conformance Statement.

OO. UCU: Unitary Control Unit, digital controller, dedicated to a specific piece of equipment, such as VAV boxes, chillers, fan coil units, heat exchangers etc.

1.4 QUALITY ASSURANCE

A. Criteria:

1. The Controls and Instrumentation System Contractor shall be a primary equipment manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Facility Management Systems of similar size, scope and complexity to the EEC specified in this Contract. Distributors, manufacturer’s representatives and wholesalers will not be acceptable.
2. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates 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.

3. 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.
4. 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.
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. 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.
7. 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.
3. Peer-to-peer controllers, unitary controllers shall conform to the requirements of UL 916, Category PAZX.

1.5 PERFORMANCE

A. The system shall conform to the following:
1. Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of (20) dynamic points per graphic. All current data shall be displayed within (10) seconds of the request.

2. Graphic Refresh: The system shall update all dynamic points with current data within (10) 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 (10) seconds. Analog objects shall start to adjust within (3) 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 (10) 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. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every five (5) seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within (5) seconds of each other.
9. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the specified system:

Measured Variable	**Reported Accuracy**
Space temperature	±0.5 degrees C (±1 degrees F)
Ducted air temperature	±1.0 degrees C [±2 degrees F]
Outdoor air temperature	±1.0 degrees C [±2 degrees F]
Water temperature	±0.5 degrees C [±1 degrees F]
Relative humidity	±2 percent RH
Water flow	±5 percent of full scale
Air flow (terminal)	±10 percent of reading
Air flow (measuring stations)	±5 percent of reading
Air pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air pressure (space)	±3 Pa [±0.001 "W.G.]
Water pressure	±2 percent of full scale *Note 1
Electrical Power	5 percent of reading

Note 1: for both absolute and differential pressure

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 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. Installation instructions for smoke dampers and combination smoke/fire dampers, if furnished.
5. Control air-supply components, and computations for sizing compressors, receivers and main air-piping, if pneumatic controls are furnished.
6. Catalog cut sheets of all equipment used. This includes, but is not limited to 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.
7. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.

8. Color prints of proposed graphics with a list of points for display.
9. Furnish PICS for each BACNET compliant device.

C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.

D. 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.

E. 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. Licenses, guaranty, and other pertaining documents for all equipment and systems.
h. 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.

F. Submit Performance Report to Project 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, 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 16hours of instructions 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 by independent or franchised dealers who are not direct employees of the controls supplier will not be acceptable.

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 degrees C (65 to 90 degrees F) at a relative humidity of 20 to 80 percent non-condensing.

B. The CUs and associated equipment used in controlled environment shall be mounted in NEMA 1 enclosures for operation at 0 to 50 degrees C (32 to 122 degrees F) at a relative humidity of 10 to 90 percent non-condensing.

C. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at –40 to 65 degrees C (-40 to 150 degrees F).

D. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.

E. 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):
Standard 135-04 ....BACNET Building Automation and Control Networks

C. American Society of Mechanical Engineers (ASME):
B16.18-01..................................Cast Copper Alloy Solder Joint Pressure Fittings.
B16.22-01..................................Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
BPVC-CC-N-04 ....Boiler and Pressure Vessel Code

D. American Society of Testing Materials (ASTM):

B32-04..Standard Specification for Solder Metal

B88-03..Standard Specifications for Seamless Copper Water Tube

B88M-05....................................Standard Specification for Seamless Copper Water Tube (Metric)

B280-03......................................Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service

D2737-03 ....Standard Specification for Polyethylene (PE) Plastic Tubing

E. Federal Communication Commission (FCC):

Rules and Regulations Title 47 Chapter 1-2001 Part 15..Radio Frequency Devices.

F. Institute of Electrical and Electronic Engineers (IEEE):

802.3-05 ....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

G. Instrument Society of America (ISA):

7.0.01-1996 ....Quality Standard for Instrument Air

H. National Fire Protection Association (NFPA):

70-05 ....National Electric Code

90A-02..Standard for Installation of Air-Conditioning and Ventilation Systems

I. Underwriter Laboratories Inc (UL):

94-06 ....Tests for Flammability of Plastic Materials for Parts and Devices and Appliances

294-05 ....Access Control System Units

486A/486B-04- ....Wire Connectors

555S-03......................................Standard for Smoke Dampers

916-Rev 2-04 ....Energy Management Equipment

1076-05 ....Proprietary Burglar Alarm Units and Systems

PART 2 – PRODUCTS

2.1 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 Operator Workstations, Servers and principal network computer 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. Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
4. The networks shall, at minimum, comprise, as necessary, the following:
   a. Operator Workstations – fixed and portable as required by the Specifications.
   b. Network computer processing, data storage and communication equipment including Servers and digital data processors.
   c. Routers, bridges, switches, hubs, modems, interfaces and the like communication equipment.
   d. Active processing network area controllers connected to programmable field panels and controllers together with their power supplies and associated equipment.
   e. Addressable elements, sensors, transducers and end devices.
   f. Third-party equipment interfaces as 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 Systems Application network shall utilize an open architecture capable of each and all of the following:
   a. Utilizing standard Ethernet communications and operate at a minimum speed of 10/100 Mb/sec.
   b. Connecting via BACNET with ANSI/ASHRAE Standard 135.
   c. LonMark as per ANSI/EIA 709 (LonWorks) to LonMark FTT-10 transceivers.
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 if required by the VA.
3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the owner.
4. The Controls Contractor shall provide the IT interfacing equipment and shall coordinate on configuration and interfacing arrangements with the Data Cabling System contractor. The Controls Contractor shall coordinate IT equipment interfacing with the Data Cabling Systems contractor. This IT equipment shall be provided by the Data Cabling systems contractor directly at that contractor’s cost. The Controls Contractor shall provide all IT interfacing equipment and cabling to a detail coordinated with the Owner.

D. Third Party Interfaces:

1. The Controls Systems shall include necessary hardware, equipment and software to allow data communications between the Controls Systems and building systems supplied by other trades.
2. The other manufacturers and contractors supplying other associated systems and equipment will provide their necessary hardware, software and start-up at their cost and will cooperate fully with the Controls Contractor in a timely manner and at their cost to ensure complete functional integration.

E. Servers:

1. Provide Controls Systems Application 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 Network Area Controllers for system configuration and custom logic definition and color graphic configuration.
3. Access to all information on the Controls Systems Server(s) shall be through the same browser Operator Interface functionality used to access individual nodes. When logged onto a Server the Operator will be able to also interact with any other NAC on the Controls As required for the functional operation of the Controls Systems, the Controls Contractor shall provide all necessary digital processor programmable Server(s). 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 the like. These Server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.

2.2 DIRECT DIGITAL CONTROLLERS

A. (NAC) Network Area Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital processor complete with all hardware, software, and communications interfaces, power supplies. The Controls System shall be designed and implemented entirely for use and operation on the Internet. NACs shall have access to data within the industry standard IT network to the Data Server and other NACs as needed to accomplish required global control strategies.

1. NACs shall provide both standalone and networked direct digital control of mechanical and electrical building system controllers as required by the Specifications. The primary NAC shall support a minimum of [5,000] field points together with all associated features, sequences, schedules, applications required for a fully functional distributed processing operation.
2. NACs shall monitor and report communication status to the Controls Systems Application. The Controls Systems shall provide a system advisory upon communication failure and restoration.

3. All NACs on the network shall be equipped with all software functionality necessary to operate the complete user interface, including graphics, via a Browser connected to the Node on the network or directly via a local port on the NAC.
4. All NAC shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.
5. The controllers shall reside on the BACnet Ethernet (ISO 8802-3) local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8, respectively of ASHRAE Standard 135, to communicate BACnet objects. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.
6. Each NAC shall be provided with the necessary un-interruptible power facilities to ensure its continued normal operation during periods of line power outages of, at minimum, 1-minute duration. Normal functionality shall include all normal software processing, communication with powered field devices and network communications with other powered Controls Systems NAC, Data Servers and OWS. Each NAC shall report its communication status to the Application. The Application shall provide a system advisory upon communication failure and restoration. Each NAC shall retain program, control algorithms, and setpoint information in non-volatile memory in the event of a power failure, and shall return to normal operation upon restoration of power.
7. Each NAC shall have sufficient memory to support its operating system, database, and program requirements, including the following:
   a. Device and network management.
   b. Data sharing.
   c. Alarm and event management including custom alarm messages for each level alarm for the points noted in the I/O Schedule.
   d. Energy management.
   e. Historical trend data for points specified.
   f. Maintenance report.
   g. Scheduling.
   h. Dial up and network communications.
   i. Manual override monitoring.
8. Each NAC shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of secondary system controllers, point capacity and programming functions.
9. Each NAC shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.

10. Each NAC shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.
11. Provide the capability to generate and modify the Controls Systems Application software-based sequences, database elements, associated operational definition information and user-required revisions to same at any designated Workstation together with the means to download same to the associated System Controllers.
12. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

B. Auxiliary Control Units (ACUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware, software and communication interfaces, power supplies, and input/output modular devices.
   1. ACUs shall reside on the BACnet Network standard network variable types and configuration properties.
   2. All ACUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
   3. Each ACU shall have sufficient memory to support its operating system, database including the following:
      a. Data sharing.
      b. Device and network management.
      c. Alarm and event management.
      d. Scheduling.
      e. Energy Management.
   4. Each ACU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.
   5. Each ACU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
   6. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

C. Unitary Control Units (UCUs) shall be microprocessor-based. They shall be capable of stand-alone operation, continuing to provide stable control functions if communication is lost with the rest of the system.
   1. Unitary Control Units shall reside on the BACnet Network.
   2. Each UCU shall have sufficient memory to support its own operating system, including data sharing.
   3. All UCUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
   4. In the event of loss of normal power, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. When power is restored flash memory, battery backup or super capacitor will be automatically loaded into non-volatile flash memory and shall be incorporated for all programming data.

D. Provide I/O module that connects sensors and actuators onto the field bus network for use by the direct digital controllers. I/O devices shall support the communication technology specified for each controller.
   1. Analog input shall allow the monitoring of low voltage (0-10 VDC), current (4-20 ma), or resistance signals (thermistor, RTD). Analog input shall be compatible with, and field configurable to commonly available sensing devices. Analog output shall provide a modulating signal for these control devices.
   2. Binary inputs shall allow the monitoring of on/off signals from remote devices. Binary inputs shall provide a wetting current of at least 12 milliamps to be compatible with commonly available control devices. Binary outputs shall provide on/off operation, or a pulsed low voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.
   3. Each output point shall be provided with a light emitting diode (LED) to indicate status of outputs.

E. Communication Ports:
   1. NACs controllers in the DDC systems shall be connected in a system local area network using protocol defined by ASHRAE Standard 135, BACnet protocol.
   2. The control supplier shall provide connectors, repeaters, hubs, and routers necessary for inter-network communication.
   3. Minimum baud rate between the peer-to-peer controllers in the system LAN shall be maintained at the rate of 10 Mbps. Minimum baud for the low level controllers between UCUs and ACUs, ACUs and NAC's shall be maintained at the rate of 76 Kbps.
   4. Provide RS-232 port with DB-9 or RJ-11 connector for communication with each controller that will allow direct connection of standard printers, operator terminals, modems, and portable laptop operator's terminal. Controllers shall allow temporary use of portable devices

without interrupting the normal operation of permanently connected modems, printers or terminals.

5. Database, such as points; status information, reports, system software, custom programs of any one controller shall be readable by any other controller on the network.

F. Diagnostic Devices (DD):
   1. Provide a laptop computer capable of accessing all system data. This device may be connected to any point on the system network or may be connected directly to any digital controller for programming, set-up, and troubleshooting.
   2. Laptop computer shall be PC notebook style containing necessary software and hardware required. The PC shall contain as a minimum:
      a. 2.4 GHZ Intel Pentium Processor.
      b. 128MB, 100 MHz RAM.
      c. 60GB Hard Drive.
      d. One-Die 256K L2 Cache.
      e. 3.5 inch, 1.44MB Floppy Disk Drive
      f. 48 X CD RW Drive.
      g. 56K Internal Modem.
      h. 32MB video memory graphics.
      i. Ethernet IP network card.
      j. Operating system compatible with PC Microsoft XP professional listed under Operator Workstation.

G. Electric Outlet: Provide a single phase, 120 VAC electrical receptacles inside or within 2 meters (6 feet) of the NAC and ACU enclosures for use with test equipment.

H. Spare Equipment:
   1. Provide spare digital controller (CU) boards and spare I/O boards as required. It shall be possible for trained hospital personnel to replace CU boards and load software via the Laptop computer or the ECC.
   2. Provide a minimum of one spare digital controller board of each type and associated parts including batteries to make at least one complete set of DDC control equipment spares.
   3. If I/O boards are separate from the CU boards, provide two spare I/O boards for each spare CU board provided above.

2.3 SENSORS (AIR, WATER AND STEAM)

A. Temperature and Humidity Sensors:
   1. Electronic Sensors: Provide all remote sensors as required for the systems. All sensors shall be vibration and corrosion resistant for wall, immersion, and/or duct mounting.

a. Temperature Sensors: Thermistor type or Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.

1) 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.

2) 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.

3) Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings. Match room thermostats, locking cover.

4) Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.

5) Room security sensors shall have stainless steel cover plate with insulated back and security screws.

6) Wire: Twisted, shielded-pair cable.

b. Humidity Sensors: Bulk polymer sensing element type.

1) Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of ± 2 to ± 5 percent RH, including hysteresis, linearity, and repeatability.

2) Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.

3) 4-20 ma continuous output signal.

c. 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.

2. Pneumatic sensors: Shall be vibration and corrosion resistant.

a. Room temperature sensors shall be linear-output type, 45 to 85 degrees F range, with bimetal sensing element, blank locking covers matching room thermostats.

b. Duct-mounted sensors shall be rigid, corrosion resistant construction and/or averaging sensor type. Averaging sensor shall be of single or multiple-unit capillary elements, 3-15 psig linear output signal and temperature range as shown on drawings.

c. Humidity Sensor: one-pipe, direct acting, with minimum sensing span of 15-85% relative humidity for 3-15 psig output signal, corrosion resistant, temperature compensated. Space mounted sensor shall match thermostats covers.

d. Differential Air Pressure Transmitter: One pipe direct acting, diaphragm type, temperature compensated; accuracy within 5 percent of full scale, and 3-15 psig output signal.

B. Water flow sensors:

1. Type: Insertion vortex type with retractable probe assembly and 2 IN full port gate valve.
   a. Pipe size: 3 to 24 IN.
   b. Retractor: ASME threaded, non-rising stem type with hand wheel.
   c. Mounting connection: 2 IN 150 PSI flange.
   d Sensor assembly: Design for expected water flow and pipe size.
   e. Seal: Teflon (PTFE).
2. Controller:
   a. Integral to unit.
   b. Locally display flow rate and total.
   c. Output flow signal to BMCS: Digital pulse type.
3. Performance:
   a. Accuracy: 1.0% of reading
   b. Repeatability: 0.15% of reading
   c. Turndown: 20:1
   d. Response time: Adjustable from 1 to 100 seconds.
   e. Power: 24 volt DC
4. Manufacturer: Emco V-Bar 910
5. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.

C. Water Flow Sensors:

1. Sensor shall be 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 minute 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.
2. Performance characteristics:
   a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5 to 100 percent humidity.
   b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30 to 250 degrees 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. Overall accuracy plus or minus one percent of reading.
   e. Repeatability: plus or minus 0.25 percent of reading.

f. 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.

g. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).

h. Ambient temperature effects, less than 0.005 percent calibrated span per degree C (degree F) temperature change.

i. RFI effect - flow meter shall not be affected by RFI.

j. Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.

D. Steam Flow Sensor/Transmitter:

1. Sensor: Vortex 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 to 80 degrees C (-40 to 175 degrees F).

b. Process conditions, 900 kPa (125 psig) saturated steam.

c. Turn down ratio, 20 to 1.

d. Accuracy, plus or minus 1.0 percent of span.

e. Repeatability, plus or minus 0.1 percent.

f. Output signal, 4-20 ma DC.

g. 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 to 50 degrees C (0-120 degrees 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.

h. 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.

E. 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.

F. 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.

2.4 CONTROL CABLES

A. As specified in Division 26.

2.5 THERMOSTATS AND HUMIDISTATS

A. Room thermostats controlling heating and cooling devices shall have three modes of operation (heating - null or dead band - cooling). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats finish and color shall be coordinated with the Architect and shall have, setpoint range and temperature display and external adjustment:

1. Pneumatic thermostats shall be 2-pipe, non-bleed or relay type design fully proportional with adjustable throttling range, direct or reverse acting as required. Factory calibrated at 17.2 kPa per degree C (2.5 psig per degree F) setpoint dial stops, adjustable sensitivity setting of 7 to 30 kPa per degree C (1 to 4 psig per degree F), and a test port to measure the output to controlled devices. Range as required.

2. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.

   a. Public Space Thermostat: Public space thermostat shall be a platinum 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. Patient Room Thermostats: Platinum sensor with set point adjustment and an indicator.

   c. Psychiatric Patient Room Sensors: Electronic duct sensor as noted under Article 2.4.

   d. 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.

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.

2.6 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): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.

1. Leakage: Except as specified in subparagraph 2 below, maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
4. Bearing shall be nylon, bronze sleeve or ball type.
5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.

D. Operators shall be electric or pneumatic type operating at 140 kPa (20 psig) as required for proper operation.

1. See drawings for required control operation.
2. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel.
3. Maximum air velocity and pressure drop through free area the dampers:
   a. Smoke damper in air handling unit; 210 meter per minute (700 fpm).
   b. Duct mounted damper; 600 meter per minute (2000 fpm).
   c. Maximum static pressure loss, 50 Pascal (0.20 inches water gage).

E. Smoke Dampers and Combination Fire/Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS. Control of these dampers is specified under this Section.

F. 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 valves shall have a linear relation or equal percentage relation of flow versus value position.
   b. Two-way valves position versus flow relation shall be linear for steam and equal percentage for water flow control.
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.
   d. Two position water valves shall be line size.

G. Damper and Valve Operators and Relays:
   1. Electric damper operator shall provide full modulating control of dampers. 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.
   2. Electronic damper operators: 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.

2.7 AIR FLOW CONTROL

A. Airflow and static pressure shall be controlled via digital controller (CUs) with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be true analog output signals to pneumatic positioners or variable frequency drives. Pulse width modulation outputs are not acceptable. The CUs 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.
   1. <u>Airflow measuring stations shall measure airflow by the pitot tube traverse method. Each unit shall consist of a network of static and total pressure sensors, factory positioned.</u>
   2. Airflow measuring stations shall consist of 16-gauge sheet metal casing, an aluminum air velocity treatment and air straightening section with an open face area not less than 97

percent and a total and static pressure sensing manifold made of copper. Each station shall contain noncombustible sensors which shall be incapable of producing toxic gases or fumes in the event of elevated duct temperatures. All interconnecting tubing shall be internal to the unit with the exception of one total pressure and one static pressure meter connection.

3. Each air flow measuring station shall be installed to meet at least the manufacturer’s minimum installation conditions and shall not amplify the sound level within the duct. The maximum resistance to airflow shall not exceed 0.3 times the velocity head for the duct stations and 0.6 times the velocity head for the fan stations. The unit shall be suitable for continuous operation up to a temperature of 120 degrees C (250 degrees F).
4. Differential pressure transducers shall measure and transmit pressure signals to the direct digital controller CU.

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 with transformer (120V/24V) 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 to 70 degrees C (-50 to 160 degrees 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 ± 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 ± 0.25%.

C. Static Pressure Measuring Station:

1. Static Pressure Control:

a. Systems 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 CU.

3) The CU 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.

D. Constant Volume Control:

1. 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 ±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 Project Engineer for resolution before proceeding for installation.
2. Work Coordination: See GENERAL CONDITIONS.
3. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
4. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
5. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
6. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
7. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
8. Install equipment level and plum.

B. Piping Installation:

1. All piping associated with smoke control shall be hard drawn copper.
2. Tubing passing through or buried in concrete shall be installed in rigid steel conduit of sufficient strength to prevent damage to tubing.
3. Except for short apparatus connections, non-metallic tubing in all exposed locations, including mechanical rooms shall be protected from damage by installing the tubing in electric conduit or raceways. Provide protective grommet where tubing exits conduit.
4. Non-metallic tubing exposed to outdoors shall be protected by a sleeve or larger tubing.
5. In concealed but accessible locations such as above lay-in ceilings, non-metallic tubing may be run without conduit or raceway.
6. All tubing which is not run in conduit or raceway, both metallic and non-metallic, shall be neatly routed and securely fastened to building structure at not more than 36-IN. intervals.
7. Welding shall be performed in accordance with Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
8. Label and identify control air piping in accordance with specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

C. Electrical Wiring Installation:
1. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
2. Install signal and communication cables in accordance with Specification Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
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. All wiring shall be installed in conduits.
4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage power is required, provide suitable transformers.
5. 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.

6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.

7. 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.

8. Grounding: ground electrical systems per manufacturer’s written requirements for proper and safe operation.

D. 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.

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.

E. Installation of Network:
1. Ethernet:
   a. The network 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: 10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10 Base T (Twisted-Pair RJ-45 terminated UTP cabling).
2. Echelon:
   a. The ECC shall employ LonTalk communications FTT-10.
   b. Echelon LAN (Flat LON): The ECC shall employ a LON LAN that will connect through an Echelon Communication card directly to all controllers on the FTT-10 LAN.
3. 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.

F. 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 Engineering Control Center 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 Owner's representative on random samples of equipment as dictated by the Owner’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 owner.
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. Pressure test control air piping at 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium. The test

pressure shall not exceed the pneumatic test pressure for any pump, valve, or other component in the system under test. Pressure shall not drop more than 5% within 4 hours.

b. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
c. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
d. Demonstrate the software ability to edit the control program off-line.
e. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.
f. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
g. 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.
h. 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.
i. 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.
j. 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 validation demonstration of Operator’s Terminal 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.

----- END -----

SECTION 23 10 00
FACILITY FUEL SYSTEMS

PART 1 – GENERAL:

1.1 DESCRIPTION:

A. Diesel fuel oil and unheated burner fuel oil tanks, piping, and accessories located outside, underground or aboveground as shown on contract drawings. Refer to contract drawings for type of fuel and for tank capacities.

B. Fuel oil quality maintenance system (water and particulate removal).

1.2 RELATED WORK:

A. Concrete ballast foundations and concrete pads: Section 03 30 53, CAST-IN-PLACE CONCRETE.

B. Sidewalk doors for underground tank manway enclosures: Section 05 50 00, METAL FABRICATIONS.

C. Platforms, stairs, ladders and railings for aboveground tanks: Section 05 50 00, METAL FABRICATIONS.

D. Sealing of pipe penetrations: Section 07 92 00, JOINT SEALANTS.

E. Primer and finish painting: Section 09 91 00, PAINTING.

F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

G. Field insulation of heated oil piping and aboveground tanks and aboveground oil piping: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

H. Steam and condensate carrier piping within tanks and access manholes: Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

I. Fuel oil pumps for boiler plant: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

1.3 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 Project 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.

1.4 SUBMITTALS:

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Fuel Piping:
   1. ASTM and UL compliance.
   2. Grade, class or type, schedule number.
   3. Manufacturer.

C. Pipe Fittings, Unions, Flanges:
   1. ASTM and UL compliance.

2. ASTM standards number.
3. Catalog cuts.
4. Pressure and temperature rating.

D. 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).

E. 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.

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. 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.
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.
5. Protect plastic piping and tanks from ultraviolet light (sunlight).

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.

1.6 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.):

A-A-60005 .... Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole

C. ASTM International (ASTM):

A36/A36M-08 .... Carbon Structural Steel

A53/A53M-10 .... Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106/A106M-10 .... Seamless Carbon Steel Pipe for High Temperature Service

A126-04(R2009)........................ Gray Iron Castings for Valves, Flanges and Pipe Fittings

A234/A234M-10 .... Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

B62-09....................................... Composition Bronze or Ounce Metal Castings

D2996-01(2007) .... Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe

D. American Society of Mechanical Engineers (ASME):

B16.5-09.................................... Pipe Flanges and Flanged Fittings (NPS ½-24).

B16.11-09.................................. Forged Fittings, Socket-Welding and Threaded

B31.1-10.................................... Code for Pressure Piping, Power Piping with Current Amendments

E. National Electrical Manufacturers Association (NEMA):

250-08 .... Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):

30-12 .... Flammable and Combustible Liquids Code

31-11 .... Installation of Oil Burning Equipment

70-11 .... National Electrical Code

G. Underwriters Laboratories Inc. (UL):

58-98 .... Steel Underground Tanks for Flammable and Combustible Liquids

142-10 .... Steel Aboveground Tanks for Flammable and Combustible Liquids

971-06 .... Non-Metallic Underground Piping for Flammable Liquids

1316-06 .... Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products

1746-07 .... External Corrosion Protection System for Steel Underground Storage Tanks

2085-10 .... Protected Above-ground Tanks for Flammable and Combustible Liquids

H. Steel Tank Institute (STI):

F001 .... Standard for Fire Resistant Tanks

F841 .... Dual Wall Underground Steel Storage Tanks

F894 .... ACT-100 Specification for External Corrosion Protection of FRP Composite Steel Underground Storage Tanks

F911 .... Standard for Diked Aboveground Storage Tank System

F941 .... Standard for Fireguard Thermally Insulated Aboveground Storage Tanks

F961 .... ACT-100-U Specification for External Corrosion Protection of Composite Steel Underground Storage Tanks

P3 .... STI-P3 Specification and Manual for External Corrosion Protection of Underground Steel Storage Tanks

R891 .... Recommended Practice for Hold Down Strap Isolation

I. NACE International (Corrosion Engineers) (NACE):

SP0169-07 .... Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NACE 3/SSPC–SP6-07 .... Commercial Blast Cleaning

NACE 4/SSPC-SP7-07 .... Brush-off Blast Cleaning

J. American Petroleum Institute (API):

1631-01 .... Interior Lining and Periodic Inspection of Underground Storage Tanks

1.7 PERMITS:

Contractor shall obtain and complete all tank permit and registration forms required by governmental authorities.

PART - 2 PRODUCTS:

2.1 PIPING, VALVES, FITTINGS:

A. Fuel supply and return, tank fill, vents, sounding, pump out, steam and condensate.

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 underground or aboveground tanks, as applicable. Removable through the extractor fitting on underground tanks. Locate valve near the top of the tank in the fill pipe. On underground tanks with gravity fill, provide two stage automatic float-operated valve. First stage operation at 92 percent tank capacity shall reduce flow to 19 L per minute (5 gallons per minute) or less. Second stage operation shall stop flow completely when tank is no more than 95 percent full. 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.

2.2 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.

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 RP-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 °C (150 °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).

2.3 CONCRETE FOUNDATIONS:

Concrete ballast foundations for underground tanks and concrete pads for aboveground tanks are specified under Section 03 30 53, CAST-IN-PLACE CONCRETE. Ballast foundations shall be sized for buoyancy of entire tank when empty. Credit for overburden is allowed.

PART 3 - EXECUTION (NOT USED)

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SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

Fuel gas systems, including piping, equipment and all necessary accessories as designated in this section. Fuel gas piping for central boiler plants is not included.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.

B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.

C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Section 22 05 23, GENERAL DUTY VALVES FOR PLUMBING PIPING

E. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Pipe Insulation.

F. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Fuel Gas Piping For Boiler Plants.

G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

H. Section 23 51 00 – BREECHINGS, CHIMEYS, and STACKS

I. Section 01 91 00 – GENERAL COMMISSIONING REQUIREMENTS

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. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

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.):

A-A-59617 .... Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections

C. American National Standards Institute (ANSI):

American Society of Mechanical Engineers (ASME): (Copyrighted Society)

A13.1-(2007) .... Scheme for Identification of Piping Systems

B16.3-(2006) .... Malleable Iron Threaded Fittings: Classes 150 and 300 ANSI/ASME

B16.9-2007................................ Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME

B16.11-2009.............................. Forged Steel Fittings, Socket-Welding and Threaded ANSI/ASME

B16.15-2006.............................. Cast Copper Alloy Threaded Fittings: Classes 125 and 250 ANSI/ASME

B31.8-2010 .... Gas Transmission and Distribution Piping Systems ANSI/ASME

D. American Society for Testing and Materials (ASTM):

A47-99(2009) .... Standard Specification for Ferritic Malleable Iron Castings

A53-10...................................... Standard Specification for Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless

A183-09.................................... Standard Specification for Carbon Steel Track Bolts and Nuts

A536-09.................................... Standard Specification for Ductile Iron Castings

A733-03(2009)e1 .... Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

B687-99(2005)e1 .... Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

E. National Fire Protection Association (NFPA):

54-2009 .... National Fuel Gas Code

F. International Code Council

IPC 2009 .... International Plumbing Code

IFGC 2009................................. International Fuel Gas Code

G. International Association of Plumbing and Mechanical Officials (IAPMO):

Uniform Plumbing Code – 2009

IS6-06....................................... Installation Standard

H. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

SP-72-2010 .... Ball Valves with Flanged or Butt-Welding For General Service

SP-110-2010 .... Ball Valve Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

1.5 SYSTEM PRESSURE

Natural gas systems are designed and materials and equipment selected to prevent failure under gas pressure of 10 psi at downstream side of pressure 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 16.9 butt welded.

D. Joints: Provide welded or threaded joints.

2.3 EXPOSED FUEL GAS PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed fuel gas 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. Pipe: Fed. Spec. WW-P-351, standard weight
2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
3. Nipples: ASTM B 687, Chromium-plated.
4. Unions: 50 mm (2 inches and smaller) Mss SP-72, SP-110, Brass or Bronze threaded with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
5. Valves: Mss SP-72, SP-110, Brass or bronze with chrome finish.

B. 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 VALVES

A. Ball Valve: Bronze body, rated for 1025 kPA at 185ºC (150 psi at 365ºF), 1725 kPa at 121ºC (250 psi at 250ºF), reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.

B. Gas Vent Cocks: Type 701: Bronze body, tee handle, rated for 205 kPa at 38ºC (30 psi at 100ºF), ground plug, rated for tight shut-off on fuel gas service.

2.5 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.

2.6 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.

2.7 DIELECTRIC FITTINGS

Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

2.8 GAS EQUIPMENT CONNECTORS

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. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between piping and openings with the fire stopping materials.
    b. 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. Install automatic shutoff valve (earthquake valve) on discharge side of meter. Valve shall positively shut off supply of gas in case of pressure failure, remain shutoff until manually reopened, and be provided with outside adjustment for reset.

3.2 CLEANING OF SYSTEM AFTER INSTALLATION

Clean all piping systems to remove all dirt, coatings and debris. Remove all valves, controls etc., and reinstall after piping system has been cleaned.

3.3 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).

3.4 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

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SECTION 23 21 11
BOILER PLANT PIPING SYSTEMS

PART 1 – GENERAL:

1.1 DESCRIPTION:

All boiler plant piping systems, except plumbing and sanitary, including piping supports. Piping located outside of the boiler plant building is not included except for gas regulator and meter stations.

1.2 RELATED WORK:

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

B. Section 23 05 10, COMMON WORK RESULTS FOR Boiler Plant and STEAM GENERATION

C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

D. Section 23 07 11, HVAC and BOILER PLANT INSULATION.

E. Fuel oil tanks and piping: Section 23 10 00, FACILITY FUEL SYSTEMSS.

F. Control valves: Section 23 52 33, WATER-TUBE BOILERS.

G. Control valves: Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

H. Flow Meters: Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

I. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

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.

1.4 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.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

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. Main steam header pressure shall be controlled at 690kPa (100psi). 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 °C (280 °F), and emergency temperature of 213 °C (415 °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 °C (212 °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 (10 psi) entering Government property. LP gas systems for igniters (pilots) are designed for maximum LP tank pressure of 1725 kPa (250 psig).

F. Fuel oil system pressures are determined by the requirements of the burners and fuel trains. No. 2 oil systems are designed for maximum temperatures of 55 °C (130 °F), and pressures of 1025 kPa (150 psi). No. 5 or 6 oil systems are designed for 120 °C (250 °F), and 1025 kPa (150 psi).

G. Water service pressures are (80 psi) maximum. Systems are designed to operate under conditions of maximum available pressure.

H. 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.

I. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psi) saturated steam.

J. Compressed air systems are designed to accommodate a maximum pressure of 850 kPa (125 psi).

K. 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):

A47/A47M-99(2009)...................Standard Specification for Ferritic Malleable Iron Castings

A48/A48M-03(2008)...................Standard Specification for Gray Iron Castings

A53/A53M-10 ....Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A105/A105M-10 ....Standard Specification for Carbon Steel Forgings for Piping Applications

A106/A106M-10 ....Standard Specification for Seamless Carbon Steel Pipe For High Temperature Service

A126-04(2009) ....Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings

A193/A193M-10 ....Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service

A194/A194M-10 ....Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both

A197/A197M-00(2006)..............Standard Specification for Cupola Malleable Iron

A216/A216M-08 ....Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High Temperature Service

A234/A234M-10 ....Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A269-10....................................Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

A395/A395M-99(2009)..............Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for use at Elevated Temperatures

A536-84(2009) ....Standard Specification for Ductile Iron Castings

B61-08......................................Standard Specification for Steam or Valve Bronze Castings

B62-09......................................Standard Specification for Composition Bronze or Ounce metal Castings

B88/B88M-09 ....Standard Specification for Seamless Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: ~~2007~~2010 Edition with current Addenda

Section I ....Power Boilers

Section IX..................................Welding and Brazing Qualifications

B16.3-2006................................Malleable Iron Threaded Fittings

B16.4-2006................................Gray Iron Threaded Fittings

B16.5-2009................................Pipe Flanges and Flanged Fittings: NPS ½ Through 24

B16.9-2007................................Factory Made Wrought Buttwelding Fittings

B16.11-2009..............................Forged Fittings, Socket-Welding and Threaded

B16.22-2001..............................Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B31.1-2010................................Power Piping

D. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

SP-45-03(2008)..........................Bypass and Drain Connections

SP-58-2009 ....Pipe Hangers and Supports-Materials, Design, Manufacture, Selection, Application, and Installation

SP-69-2003 ....Pipe Hangers and Supports-Selection and Application

SP-80-2008 ....Bronze, Gate, Globe, Angle and Check Valves

SP-89-2003 ....Pipe Hangers and Supports-Fabrication and Installation Practices

SP-90-2000 ....Guidelines on Terminology for Pipe Hangers and Supports

SP-97-2006 ....Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded and Buttwelding Ends

SP-127-2001 ....Bracing for Piping Systems Seismic – Wind – Dynamic Design, Selection, Application

E. National Fire Protection Association (NFPA):

30-2008 ....Flammable and Combustible Liquids Code

31-2011 ....Standard for the Installation of Oil Burning Equipment

F. American Welding Society (AWS):

B2.1-2009..................................Specification for Welding Procedure and Performance Qualification

G. Pipe Fabrication Institute (PFI):

PFI ES-24-08 ....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.

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.ll, 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-l/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.ll, 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 FUEL PIPING:

A. Natural gas, fuel oil (No. 2) for main burner and igniter (pilot) fuels, gas vent piping. Comply with ASME B3l.l.

B. Piping: Carbon steel, ASTM A53 Grade B or ASTM A106 Grade B, seamless or ERW, Schedule 40. Fuel oil piping shall be seamless downstream of burner automatic shutoff valves.

C. Joints:

1. Pipe sizes 65 mm (2-l/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: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
2. Socket-welded joints: Forged steel, ASME B16.ll, 13,790 kPa (2000 psi class.

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: Forged steel weld neck, ASME B16.5, ASTM A105, 1025 kPa (150 psi).

G. Companion flanges: Flanges and bolting shall conform to ASME B16.5.

H. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B3l.l, for the actual operating conditions.

I. Igniter (Pilot) Piping: Furnished as part of the factory assembled burners may have 2050 kPa (300 psi) ASTM A47, ASME B16.3 malleable iron threaded fittings in lieu of welded steel. If threaded fittings are provided, piping shall be Schedule 80.

2.4 BOILER FEEDWATER PIPING:

A. Piping from boiler feedwater pump discharge to inlet of boilers.

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.ll, 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 BOILER 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 BOILER 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.ll, 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-l/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 SOFTENERS.

B. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

2.9 COMPRESSED AIR PIPING (FUEL OIL ATOMIZING 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.ll, 13,790 kPa (2000 psi class); or malleable iron ASTM A47 or A197, ASME Bl6.3, 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 BOILER WATER SAMPLING, CONTINUOUS BLOWDOWN:

A. Pipe: Steel, ASTM A106 Grade B, seamless, Schedule 80.

B. Joints: Threaded.

C. Fittings: Forged steel, ASME B16.ll, 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.

2.11 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING:

A. Pipe: Stainless steel tubing, ASTM A269, Type 316.

B. Fittings: Stainless steel Type 316 welding fittings.

2.12 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.ll, 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.ll, 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.

2.13 DIELECTRIC FITTINGS:

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 °C (80 °F). Fittings on steam condensate lines shall be rated at 510 kPa (75 psi), 120 °C (250 °F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

2.14 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 B3l.l. 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 A2l6 WCB, rated for 1025 kPa at 260 °C (150 psi at 500 °F), ll-l/2 to l3 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 l02: Cast iron body ASTM Al26 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 Al26 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 B6l, 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 l05: 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), 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 °C (150 psi at 500 °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 B6l, 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 Al26 Class B, rated for 1200 kPa (l75 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: natural gas, LP gas (propane), or fuel oil. 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 Al26 Class B, rated for 850 kPa (l25 psi) saturated steam, 1375 kPa (200 psi) WOG, bronze or bronze-faced disc and seat, 850 kPa (l25 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 °C (300 psi at 420 °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 °C (250 psi at 360 °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 °C (250 °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 °C (250 °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 1025 kPa at 185 °C (150 psi at 365 °F), 4130 kPa at 93 °C (600 psi at 200 °F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.

b. Type 502: Bronze body, rated for 1025 kPa at 185 °C (150 psi at 365 °F), 1725 kPa at 121 °C (250 psi at 250 °F), reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.

c. Type 503: Carbon steel or ASTM B61 bronze body, steam service, rated for 1380 kPa at 200 °C (200 psi at 390 °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 °C (125 psi at 250 °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 °C (150 psi at 500 °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.

7. Gas Vent Cocks:
   a. 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.

C. Boiler 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, 0S&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-l/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. Fuel Oil: Discharge side of pumps. Conform to NFPA Code Nos. 30 and 3l.

1. Gate valves, 50 mm (2 inches) and under: Type l04.
2. Gate Valves, 65 mm (2-l/2 inches) and above: Type l0l or 102.
3. Globe valves, 50 mm (2 inches) and under: Type 204.
4. Plug valves, 100 mm (4 inches) and under: Type 301. (Tank isolating valve on return line.)
5. Check valves, 50 mm (2 inches) and under: Type 404 or 408.
6. Check valves, 65 mm (2-l/2 inches) and above: Type 402 or 408.
7. Ball valves, 50 mm (2 inches) and under: Type 502.

L. Fuel Oil: Suction side of pumps and tank fill lines where tank is below fill point. Conform to NFPA Code Nos. 30 and 3l.

1. Gate valves, 50 mm (2 inches) and under: Type l04.
2. Gate valves, 65 mm (2-l/2 inches) and above: Type l03.
3. Plug valves, 100 mm (4 inches) and under: Type 301.
4. Check valves, 50 mm (2 inches) and under: Type 404.
5. Check valves, 65 mm (2-l/2 inches) and above: Type 403.
6. Ball valves, 50 mm (2 inches) and under: Type 502.

M. Fuel Gas: Main fuel and igniter (pilot) systems.

1. Plug valves, 100 mm (4 inches) and under: 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.

N. Compressed Air:

1. Gate valves, 50 mm (2 inches) and under: Type l04.
2. Ball valves, 50 mm (2 inches) and under: Type 502.

O. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.

P. Soft Water: See Section 22 31 11, WATER SOFTENERS.

Q. Instrumentation and Control Piping:

Ball valves, 50 mm (2 inches) and under: Type 502.

R. Non-Boiler 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.

2.15 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 °C (150 psi, 300 °F).

2.16 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 °C (310 °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 °C (100 psi, 300 °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 Project Engineer.

2.17 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. Boiler and Economizer Service: Refer to Section 23 52 33, WATER-TUBE BOILERS.

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. Fuel Oil Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

E. Compressed Air Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.

F. 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.

2.18 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. Sound Levels: Refer to requirements in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

2.19 STRAINERS, SIMPLEX BASKET TYPE

A. Provide on condensate lines where shown. Refer to Section 23 50 11, BOILER 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 °C (212 °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.

2.20 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 °C (250 psi at 450 °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 °F (250 psi at 450 °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.

2.21 LIQUID PETROLEUM TANKS GAS PRESSURE REGULATORS

A. Type: Single stage or two-stage designed to reduce tank pressure to LPG header pressure (35 kPa)(5 psi). Outlet pressure shall be adjustable. Design for LPG (propane) service. Valve shall be weatherproof for outside installation. Valve body shall be designed for 1725 kPa (250 psi). Provide internal relief valve set at 69 kPa (10 psi).

B. Performance: Valve shall provide steady outlet pressure of 35 kPa (5 psi) with flow rate required by igniters (pilots) furnished, with tank pressure variation from 1725 to 140 kPa (250 to 20 psi).

2.22 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

2.23 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 °C (200 °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.

2.24 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% 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 show locations and types of resilient supports including rollers and springs, and may also show special supports including anchors, guides and braces. Comply with the drawing requirements unless it is determined that piping may be overstressed or supports overloaded. Refer conflicts to the RE/COTR.
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 BOILER 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.

2.25 PIPE AND VALVE FLANGE GASKETS

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.

2.26 THREAD SEALANTS:

As recommended by the sealant manufacturer for the service.

2.27 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 Project 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. They must comply with MSS-SP-97.

3.5 EXPANSION AND FLEXIBILITY

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

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

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

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

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

Where copper piping is connected to steel piping provide dielectric connections.

3.11 INSTALLATION - BOILER EXTERNAL STEAM PIPING FROM BOILER TO MAIN HEADER

A. From Boiler to Second Stop Valve: Fabricate from boiler nozzle through second stop valve under the rules for boiler 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 boiler, 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 kPag (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 BOILER 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 - BOILER BOTTOM BLOWOFF PIPING

Fabricate with long radius ells, Y-form laterals. Tees and crosses are not permitted.

3.14 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF

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

Locate to permit view from floor or platform.

3.16 INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES

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

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

Install with basket level with the steam pipe so that condensate is not trapped in the strainer.

3.21 INSTALLATION - QUICK COUPLE HOSE CONNECTORS

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

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 LP gas piping at the maximum tank pressure, 1725 kPa (250 psig), with compressed air. 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 boiler 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. 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 39, FIRE-TUBE BOILERS, Section 23 52 33, WATER-TUBE BOILERS for boiler safety valve test requirements.

3.27 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

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 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

B. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Requirements for piping insulation.

1.3 QUALITY ASSURANCE

A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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.

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):

495-1999 (R2002)......................Standard for Refrigerant Liquid Receivers

730-2005....................................Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers

750-2007....................................Thermostatic Refrigerant Expansion Valves

760-2007....................................Performance Rating of Solenoid Valves for Use with Volatile Refrigerants

C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):

ANSI/ASHRAE 15-2007.............Safety Standard for Refrigeration Systems (ANSI)

ANSI/ASHRAE 17-2008.............Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)

63.1-95 (RA 01)..........................Method of Testing Liquid Line Refrigerant Driers (ANSI)

D. American National Standards Institute (ANSI):

ASME (ANSI)A13.1-2007 .... Scheme for Identification of Piping Systems

Z535.1-2006.............................. Safety Color Code

E. American Society of Mechanical Engineers (ASME):

ANSI/ASME B16.22-2001 (R2005)

Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)

ANSI/ASME B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)

ANSI/ASME B31.5-2006........... Refrigeration Piping and Heat Transfer Components (ANSI)

ANSI/ASME B40.100-2005........ Pressure Gauges and Gauge Attachments

ANSI/ASME B40.200-2008........ Thermometers, Direct Reading and Remote Reading

F. American Society for Testing and Materials (ASTM)

A126-04..................................... Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe FittingsB32-08 Standard Specification for Solder Metal

B88-03....................................... Standard Specification for Seamless Copper Water Tube

B88M-05.................................... Standard Specification for Seamless Copper Water Tube (Metric)

B280-08..................................... Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

G. American Welding Society, Inc. (AWS):

Brazing Handbook

A5.8/A5.8M-04 .... Standard Specification for Filler Metals for Brazing and Braze Welding

H. Federal Specifications (Fed. Spec.)

Fed. Spec. GG

I. Underwriters Laboratories (U.L.):

U.L.207-2009 .... Standard for Refrigerant-Containing Components and Accessories, Nonelectrical

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. Brazed 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. Steel fittings: ASTM wrought steel fittings.
   a. Refrigerant piping – Welded Joints.
3. Flanges and flanged fittings: ASME B16.24.
4. Refrigeration Valves:
   a. 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.
   b. 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.
5. 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.
6. 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.
7. 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.
8. 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 REFRIGERANTS AND OIL

A. Provide EPA approved refrigerant and oil for proper system operation.

2.4 PIPE/CONDUIT ROOF PENETRATION COVER

A. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 300 mm (12 inches) overall height, continuous welded corner seams, treated wood nailer, 38 mm (1-1/2 inch) thick, 48 kg/cu.m (3 lb/cu.ft.) 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.

B. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 38 mm (1-1/2 inch) thick mineral fiber board insulation.

C. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

2.5 PIPE INSULATION FOR DX HVAC SYSTEMS

Refer to specification Section 23 07 11, HVAC, PLUMBING, and BOILER 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. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

F. 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. 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.

B. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 13 mm (1/2 inch) in height designating:

1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

3.4 FIELD QUALITY CONTROL

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.

A. 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 Project 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.

B. 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.

- - - 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.

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.

1.2 RELATED WORK

A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.

B. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS and VENTS.

C. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

F. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION

G. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.

H. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

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 COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05

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):

ASCE7-05 ....Minimum Design Loads for Buildings and Other Structures

C. American Society for Testing and Materials (ASTM):

A167-99(2009) ....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

A653-09	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
A1011-09a	Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B209-07	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C1071-05e1	Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
E84-09a	Standard Test Method for Surface Burning Characteristics of Building Materials

D. National Fire Protection Association (NFPA):

90A-09	Standard for the Installation of Air Conditioning and Ventilating Systems
96-08	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

2nd Edition – 2005	HVAC Duct Construction Standards, Metal and Flexible
1st Edition - 1985	HVAC Air Duct Leakage Test Manual
6th Edition – 2003	Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-08	Factory-Made Air Ducts and Air Connectors
555-06	Standard for Fire Dampers
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. Optional Duct Materials:

1. Grease Duct: Double wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust duct. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of

exposed ductwork shall be stainless steel. Square and rectangular duct shown on the drawings will have to be converted to equivalent round size.

D. 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.
E. 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:

   0 to 50 mm (2 inch)

   > 50 mm to 75 mm (2 inch to 3 inch)

   > 75 mm to 100 mm (3 inch to 4 inch)

   Show pressure classifications on the floor plans.
C. Seal Class: All ductwork shall receive Class A Seal
D. Operating Room/Cystoscopy Room Supply Air: All supply air ductwork on the downstream side of the terminal final HEPA filter serving an operating room or cystoscopy room shall be fabricated from welded stainless steel, including all components of the air distribution system up to and including the supply air outlet.
E. Wet Air Exhaust Ducts and Accessories: Ducts for dishwashers, scullery hood, cart washers, manual cart washers, cage washers, steam sterilizer hoods and orthotics hoods shall be 1.3 mm (18 gage) stainless steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access door in side of duct at drain pockets.
F. 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.

G. 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.

H. 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.

I. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

J. Ductwork in excess of 620 cm^2 (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 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.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Where duct connections are made to fans 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.

2.5 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.

2.6 FIRESTOPPING MATERIAL

A. Refer to Section 07 84 00, FIRESTOPPING.

2.7 SEISMIC RESTRAINT FOR DUCTWORK

A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.8 DUCT MOUNTEDTEMPERATURE SENSOR (AIR)

A. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

2.9 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.

2.10 AIR FLOW CONTROL VALVES (AFCV)

A. Refer to Section 23 36 00 / 23 82 00, AIR TERMINAL UNITS / CONVECTION HEATING and COOLING UNITS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, 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. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.

K. 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. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.

B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. //Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Resident Engineer on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated. //

C. 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.

D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.

E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.

F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.

G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.

H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

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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 l-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 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

F. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

H. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Fans and power ventilators shall be listed in the current edition of AMCA 26l, 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:

  l. Testing and Rating: AMCA 2l0.

  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:

  l. 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 conditions.

  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. Fans for general purpose fume hoods, or chemical hoods, and radioisotope hoods shall be constructed of materials compatible with the chemicals being transported in the air through the fan.

I. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20% 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.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Manufacturers Literature and Data:
   l. Fan sections, motors and drives.
   2. Centrifugal fans, motors, drives, accessories and coatings.
      a. Industrial fans.
      b. Utility fans and vent sets.
   3. Prefabricated roof curbs.
   4. Power roof and wall ventilators.
   5. Packaged hood make-up air units.

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.

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 Movement and Control Association International, Inc. (AMCA):
   99-86 ....Standards Handbook

2l0-06 .... Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

26l-09 .... Directory of Products Licensed to bear the AMCA Certified Ratings Seal - Published Annually

300-08 .... Reverberant Room Method for Sound Testing of Fans

C. American Society for Testing and Materials (ASTM):

B117-07a................................... Standard Practice for Operating Salt Spray (Fog) Apparatus

D1735-08 .... Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus

D3359-08 .... Standard Test Methods for Measuring Adhesion by Tape Test

G152-06 .... Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

G153-04 .... Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

D. National Fire Protection Association (NFPA):

NFPA 96-08 .... Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

E. National Sanitation Foundation (NSF):

37-07 .... Air Curtains for Entrance Ways in Food and Food Service Establishments

F. Underwriters Laboratories, Inc. (UL):

181-2005 .... Factory Made Air Ducts and Air Connectors

1.6 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. Fan arrangement, unless noted or approved otherwise:

l. DWDl fans: Arrangement 3.

2. SWSl fans: Arrangement l, 3, 9 or l0.

C. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.

l. 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 Bl0 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.
6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
7. 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.
8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION for specifications. Provide protective sheet metal enclosure for fans located outdoors.
9. 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 AND STEAM GENERATION for controller/motor combination requirements.

D. 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.

E. Utility Fans, Vent Sets and Small Capacity Fans: Class l design, arc welded housing, spun intake cone. Applicable construction specification, paragraphs A and C, for centrifugal fans shall apply for wheel diameters 300 mm (l2 inches) and larger. Requirement for AMCA seal is waived for wheel diameters less than 300 mm (l2 inches) and housings may be cast iron.

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 POWER ROOF VENTILATOR

A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.

B. Type: Centrifugal fan, backward inclined blades. Provide down-blast or up-blast type as indicated.

C. Construction: Steel or aluminum, completely weatherproof, for curb mounting, exhaust cowl or entire drive assembly readily removable for servicing, aluminum bird screen on discharge, UL approved safety disconnect switch, conduit for wiring, vibration isolators for wheel, motor and drive assembly. Provide self acting back draft damper.

D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.

E. Prefabricated Roof Curb: As specified in paragraph 2.3 of this section.

F. Up-blast Type: Top discharge exhauster, motor out of air stream. For kitchen hood exhaust applications, provide grease trough on base and threaded drain. The mounting height of the kitchen up-blast exhaust fan shall be in compliance with NFPA 96. (Provide vented curb extension if required to maintain required clearances.)

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.

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SECTION 23 50 11
BOILER PLANT MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

Compressed air systems, blowoff tank, blowdown heat recovery, chemical treatment systems, steam vent silencer, and other equipment that supports the operation of the boilers.

1.2 RELATED WORK

A. Section 09 91 00, PAINTING.

B. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

C. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

E. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. 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.

C. Boiler Water and Deaerator Water Sample Coolers:

1. Drawings with dimensions, and sizes and location of piping connections.
2. Catalog data and specification sheets on the design and construction.
3. Pressure and temperature limitations.
4. Amount of heat exchange surface.

D. Chemical Feed Systems (Pump Type):

1. Drawings with dimensions of entire unit. Include locations and sizes of all pipe connections.
2. Catalog data and specification sheets on the design and construction of pump, mixer, tank, controls.
3. Performance data on pump including head, flow, motor power. Refer to schedules on drawings for requirements.
4. Pressure and temperature limitations of unit and accessories.
5. Information on suitability of materials of construction for chemicals to be utilized.

E. 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.

F. Test Data – Acceptance Tests, On-Site: Four copies all specified tests.

G. 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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

H. Seismic Restraint Data: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

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):

A53/A53M-07 .... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106/A106M-08 .... Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service

A234/A234M-10 .... Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A285/A285M-03(2007)............... Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate – Tensile Strength

A414/A414M-10 .... Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy for Pressure Vessels

A515/A515M-03(2007)............... Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-temperature Service

A516/A516M-06 .... Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate-and Lower-Temperature Service

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code: 2007 Edition with Amendments.

Section VIII .... Pressure Vessels, Division I and II. Performance Test Code:

PTC 12.3-1997.......................... Performance Test Code for Deaerators

B16.9-2007................................ Factory-Made Wrought Butt Welding Fittings

B16.34-2009.............................. Valves, Flanged, Threaded and Welding End

D. National Board of Boiler and Pressure Vessel Inspectors:

NB-23-2007................................Inspection Code

E. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):

ASHRAE Handbook...................2008 HVAC Systems and Equipment

F. Society for Protective Coatings (SSPC):

SP 5-2007 ....White Metal Blast Cleaning

E. Underwriters Laboratories (UL):

574-03 ....Standard for Electric Oil Heaters

PART 2 - PRODUCTS

2.1 COMPRESSED AIR SYSTEM

A. Provide complete compressed air system to serve oil burner cold start atomization (steam-atomizing oil burners), 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: Reciprocating, two-stage, air-cooled, intercooled, V-belt 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: Vertical or 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 BOILER 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. Compressor Serving Oil Burner Cold Start Atomization, Oil Tank Gauges, and Flue Gas Oxygen Analyzers Only: Automatic start-stop control actuated by pressure in receiver. Pressure settings shall be adjustable.
2. Compressors Serving Boiler Plant Controls or Instruments: Dual control enabling the manual selection of either automatic start-stop control (actuated by adjustable receiver pressure switch), or constant speed control in which the compressor runs constantly but only compresses air between predetermined adjustable receiver pressure limits.
3. 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, BOILER 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 boiler 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.

2.2 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.

2.3 CHEMICAL FEED SYSTEMS, PUMP TYPE

A. Type: Factory-assembled packaged units, each consisting of chemical tank, pump, mixer, support base, controls, accessories.

B. Service: Design units for storing mixture of boiler or deaerator water treatment chemicals, or steam distribution system treatment chemicals, and pumping the chemicals at an adjustable controlled rate into the boilers or deaerator or steam header as shown. Units shall be suitable for boiler and feedwater deaerator water treatment chemicals including: Caustic soda, soda ash, trisodium phosphate, disodium phosphate, sodium metaphosphate, sodium sulfite, amines and various commercially available water and steam line treatment compounds.

C. Pump: Continuous duty, Teflon diaphragm-type, actuated with seal-less hydraulics, submerged oil bath lubricated power train, 316 stainless steel cartridge type double ball check valves on suction and discharge, totally-enclosed standard NEMA frame motor. 316 stainless steel casings designed for 1725 kPa (250 psi) minimum. Check valves shall be removable for cleaning or replacement without disturbing piping. Pump capacity must be adjustable through 100% of range by micrometer dial while the pump is running or stopped. Mount pump under tank with cast iron strainer and ball valve on suction pipe and ball valve in discharge pipe.

D. Mixer: Direct drive, 1750 RPM, mounted on tank with angle adjustment. Totally enclosed motor, stainless steel propeller.

E. Tank: Polyethylene with hinged cover. 190 liter (50 gallon) capacity. Provide 5 gallon indicating increments molded into side of tank. Steel support frame and mixer bracket.

F. Controls: NEMA 250, Type 12 panel with stop-start switches, motor protection and pilot lights indicating each motor in operation and "power on". Provide low level pump cut off with indicating light. Provide devices to signal computer work station that pumps are on or off.

G. Relief Valve: Rated for maximum pump capacity, set at 1200 kPa (175 psi).

2.4 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, BOILER 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 and Condensate Transfer 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. Mechanical Condensate Pump (Pumping Trap): Provide sufficient elevation difference between the receiver condensate inlet and outlet and the trap inlet to assure the required head for proper functioning and capacity. Steam supply line shall include gate valve and Y-type strainer.

D. Condensate Return Pump Units (Sump Type): Provide the exterior of new receiver tanks with two heavy coats of asphalt or bituminous waterproofing compound. Mounting into the floor shall include waterproofing gaskets and grouting that will prevent ground water from entering the building from around the receiver. Unit shall be level.

E. Fuel Oil Pumping Equipment and Fuel Oil Heaters and Accessories: Locate equipment to permit access to all valves and controls, and to permit removal and cleaning of heat exchanger tubes.

F. 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.

G. 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 TESTING AND BALANCING FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES:

A. Demonstrate the ability of the deaerator to perform as specified in regard to oxygen removal and outlet temperature, over the required output flow range and input temperature range of unit. Test performance at 5 percent and 100 percent of capacity, and at two intermediate points to be selected by the PE/COTR. Repeat test two times at each load point.

B. Determine temperatures and pressures by calibrated thermometers and pressure gages.

C. Utilize the specified colorimetric comparator type dissolved oxygen test kit. After completion of tests, clean the test kit apparatus, replace all ampoules used and parts missing or broken, and deliver the kit to the PE/COTR.

D. Various impurities in feed water can interfere with the colorimetric test. When impurities are present, the Contractor shall be prepared to test for dissolved oxygen using the titration test as described in ASME PTC 12.3. PE may permit other test methods.

E. This test shall be performed in conjunction with any boiler tests that are specified.

F. Prior to requesting final tests, pretest unit using method specified for final test. All final test must include at the minimum the test listed in the most recent edition of the VHA Boiler Plant Safety Device Testing Manual. Submit test data for review.

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 the Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 each VA personnel responsible in operation and maintenance of units.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 – GENERAL:

1.1 DESCRIPTION:

This section specifies flue gas exhaust system and all accessories from the boiler outlet to the stack outlet to the atmosphere. Flue gas recirculation (FGR) ductwork (if required by burners furnished) is also specified.

1.2 RELATED WORK:

A. Section 07 60 00, FLASHING and SHEET METAL: Roof Penetrations.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS,

C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

D. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

E. Section 23 52 33, WATER-TUBE BOILERS: Economizers

F. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Boiler Draft Control System.

1.3 QUALITY ASSURANCE:

A. Provide scale drawings showing nominal dimensions and weight of the systems.

B. Boiler and burner manufacturer shall review complete system from boiler flue gas outlet to stack outlet to atmosphere and advise the Government of any changes required to meet boiler and burner performance requirements. Note the altitude of plant site.

C. 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 Project Engineer (RE) that the entire installation complies with the official standards of the manufacturer and with the project specifications.

D. Flue gas recirculation ductwork shall be designed and provided by the burner manufacturer.

E. 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. Design, materials, weights, construction, pressure and temperature limitations of breeching and stack systems, flue gas recirculation system.

C. Drawings showing all components, system arrangement and dimensions.

D. Design, construction, allowable movements, movement forces, pressure and temperature limitations of expansion joints.

E. Damper design, construction, pressure and temperature limitations, pressure loss at design flow, and leakage of closed damper.

F. Support designs, locations and loads for entire assembly. G. Written statement from boiler/burner manufacturer 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):

Steel Construction Manual, Thirteenth Edition

C. ASTM International (ASTM):

A36/A36M-08 ....Standard Specification for Carbon Structural Steel

A242/A242M-04(2009)..............Standard Specification for High-Strength Low-Alloy Structural Steel

A307-07b...................................Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

A563-07a...................................Standard Specification for Carbon and Alloy Steel Nuts

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):

Dl.l/D1.1M-2010 ....Structural Welding Code-Steel

E. Manufacturer’s Standardization Society of the Valves and Fittings Industry (MSS):

SP-58-2009 ....Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation

F. National Fire Protection Association:

NFPA 54-2006 ....National Fuel Gas Code

NFPA 31-2006 ....Standard for the Installation of Oil-Burning Equipment

PART 2 – PRODUCTS:

2.1 BREECHING, STACKS, FGR DUCTWORK:

A. Refer to drawings for arrangement and dimensions, except FGR ductwork shall be designed by the burner manufacturer. Connections to boilers and economizers must comply with the written recommendations of the boiler and economizer manufacturers. Ninety-degree tee sections are not permitted. Intersections must be made with lateral tees.

B. Service: Design for continuous 315 °C (600 °F), 12 kPa (50 inches WC) positive and negative internal pressure, wind-loading for outside stacks. 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. Double wall, circular cross section, positive pressure, blanket insulation between walls.
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 50 mm (2 inches) clearance to combustible materials and 50 mm (2 inches) clearance to non-combustible materials.
7. Inner Wall: Stainless steel, Type 304, 0.95 mm (0.0375-inch) minimum thickness for diameters 900 mm (36 inches) and smaller and 1.27 mm (0.05 inches) minimum thickness for diameters greater than 900 mm (36 inches).
8. Outer Wall: 304 stainless steel inside and outside of building, 0.51 mm (0.02 inch) minimum thickness for inner wall diameter 900 mm (36 inches) and less, 0.95 mm (0.0375 inch) minimum thickness for inner wall diameter over 900 mm (36 inches).
10. Insulation Between Walls: 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.

16. Provide test parts as shown on the drawings.

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).

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 INSTALLATION - CUSTOM-DESIGNED, FIELD-FABRICATED, STEEL SINGLE 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 as shown on the drawings. Refer to seismic requirements in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

B. Joints: Provide continuous weld between boiler outlet and connecting transition, breeching or stub stack and at connections to economizers, when recommended by manufacturer of economizer or boiler. Securely bolt all remaining joints and provide gaskets rated for service at 315 °C (600 °F).

C. Field-Applied Insulation: Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

D. Connect 25 mm (1 inch) minimum pipes with ball valves to breeching and stack drains. Extend to floor drain.

E. Boiler or Economizer Outlet Dampers: Locate so that there is no restriction in the flow of flue gas recirculation (if provided).

F. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

G. Install in accordance with NFPA 54 and NFPA 31.

3.3 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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SECTION 23 52 33
WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies packaged water tube boiler with trim (accessories), dual fuel (natural gas and fuel oil) burner, fuel trains and flue gas economizer.

1.2 RELATED WORK:

A. Section 09 91 00, PAINTING.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

C. Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

D. Section 23 21 11, BOILER PLANT PIPING SYSTEMS: Valves for boiler trim, non-return stop-check valve, piping for fuel and feedwater trains.

E. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS: Boiler outlet damper systems, breechings, stacks, flue gas recirculation (FGR) ductwork.

F. Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT: Burner controls, combustion control system, boiler water level control, pressure gages, thermometers.

G. Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

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, fuel oil header back pressure regulator on house oil pump set and available fuel oil pressure, burner control system, combustion control system, economizer (if provided), 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. The model and size of the proposed burner shall have been previously applied to at least three boilers that are similar in size, proportion, and arrangement to the proposed boiler made in USA. In each of the three installations, burner performance shall have conformed to requirements listed in Part 2, BURNER and FUEL TRAINS. Provide list of these installations, and name, address and telephone number of person familiar with each project who will serve as a reference source.

D. 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.

1.4 SUBMITTALS:

A. Before executing any work, submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Boiler:

1. Complete catalog information and outline drawing of boiler 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. Furnace viewport construction, locations.
12. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
13. Predicted surface temperature at front, rear and sides of boiler.
14. Seismic design data on boiler and anchorage of boiler to foundation. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

C. Boiler 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 boiler 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 pressure drop 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 boiler.
8. Set pressure and capacity of safety valves.

D. Burner and Fuel Trains:
1. Catalog data and drawings showing construction of burner parts and assembly of complete system.
2. Drawings, with dimensions, showing burner over all size and mounting on the boiler.

3. Catalog data and outline drawings of forced draft fan, flue gas recirculation ductwork (if provided), dampers, motors and sound attenuators on fan intake or discharge.
4. Drawings showing assembly of throat refractory into furnace refractory wall.
5. Type and temperature rating of throat refractory.
6. Drawings and catalog data on all equipment in igniter (pilot) train, main fuel trains, atomizing media train. Include data on pressure and temperature ratings, flow vs. pressure drop, performance characteristics, and inspection agency approvals. Complete data on oil atomization air compressor systems with sound attenuators.
7. ASTM number and schedule numbers on all piping.
8. Type and pressure ratings of pipe fittings.
9. Burner flow and pressure data:
    a. Main burner fuel and atomizing media pressures 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 and LP gas) at outlet of burner-mounted pressure regulators.
    e. Forced draft fan static pressure, power and air flow at maximum firing rate. Amount of flue gas recirculation.
10. Full load efficiency and power factor of all motors.
11. Predicted sound level at maximum firing rate.
12. Weight of burner assembly.
13. Drawings showing location and arrangement of drive units and jackshaft system (if provided) for controlling fuel and air flow.
14. Weight of burner assembly.

E. Burner Management (Flame Safeguard) Control System: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

F. Flue Gas Economizer:
1. Drawings showing arrangement and dimensions of unit and all accessories.
2. Design and construction of unit and accessories including soot blowers, safety relief valve.
3. Weight of entire unit, empty and flooded.
4. Pressure and temperature limitations of unit and accessories.
5. Performance data on safety relief valve.
6. Drawing showing tube arrangement, clearance for tube removal (rectangular units) and soot blower nozzle locations. Written recommendations of soot blower manufacturer on number of elements and locations of nozzles for this economizer design and size.
7. Manufacturers operating recommendations for mounting and support requirements for economizer (weight-flooded).

G. Seismic data. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

H. Boiler and Burner Predicted Performance Data, for Each Fuel, Site Altitude:

1. At Maximum Required Output With and Without Economizer (If Applicable) In Service, at 15 Percent Excess Air: Fuel and steam flow, boiler flue gas outlet temperature, economizer (if provided) flue gas outlet temperature, steam quality, boiler efficiency, windbox and furnace pressures, predicted boiler radiation and unaccounted losses, feedwater and flue gas pressure losses in the economizer (if provided).
2. At Low Fire, 25%, 50% and 75% of Maximum Firing Rate: Percent excess air, carbon monoxide (CO) ppm and NOx ppm.

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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 PROJECT CONDITIONS:

A. Fuels to be Fired, Main Burner: Natural gas No. 2 fuel oil or amber fuel.

B. Igniter (Pilot) Fuels: Natural Gas and LP gas (propane).

C. Natural Gas: High heating value is reported as 373 MJ per cubic meter (1000 Btu per cubic foot) at gas company base pressure and temperature. Pressure provided to the inlet of the boiler-mounted regulators will be (10 psi) as maintained by the main gas regulator station.

D. Fuel Oil: Will be furnished under existing system. Pressure will vary in accordance with characteristics of backpressure regulator on house oil pump set. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT. Oil grade (No. 2 or amber) refers to ASTM D396.

E. Low Pressure Air Atomizing Burners: Each burner must include a dedicated air compressor system furnished by burner manufacturer.

F. Oil Atomizing Media:

1. Steam Atomizing Burners: Steam pressure range at inlet to atomizing train 620 to 758 kPa (90 to 110 psi). When plant is cold (steam not available), compressed air (0.8 standard cubic meters per minute at 550 kPa) (30 SCFM at 80 psi) is available (from plant compressor) as an alternate for starting any boiler and continuously operating it at a required steam output of 13 percent of full load.
2. Low Pressure Air Atomizing Burners: May be furnished at the option of the Contractor. Each burner must include a dedicated air compressor system furnished by burner manufacturer.

G. LP Gas (Propane): Furnished to the Government for igniter (pilot) fuel by a local supplier. Regulators at tank areas will be set at 35 kPa (5 psi). Serves as igniter fuel when there is an interruption to the natural gas supply.

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. ASTM International (ASTM):

A106/A106M-08 .... Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.

A178/178M-02(2007) .... Standard Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes

A269-10..................................... Standard Specification for Seamless and Austenitic Welded Stainless Steel Tubing for General Service

C612-10..................................... Standard Specification for Mineral Fiber Block and Board Thermal Insulation

D396-09a................................... Standard Specification for Fuel Oils

C. American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code - 2007 Edition with Amendments.

Section I .... Power Boilers

Section II .... Material

Section VII .... Recommended Rules for Care of Power Boilers

Section IX .... Welding and Brazing Qualifications

Performance Test Code (PTC):

PTC 4-2008................................ Fired Steam Generators

Code for Pressure Piping:

B31.1-2007................................ Power Piping

D. National Fire Protection Association (NFPA):

70-2008 .... National Electric Code

85-2007 .... Boiler and Combustion Systems Hazards Code

E. National Board of Boiler and Pressure Vessel Inspectors (NBPVI):

NB-232007 .... National Board Inspection Code

F. Fluid Controls Institute (FCI):

70-2-2006 .... Control Valve Seat Leakage

G. Department of Health and Human Services, Food and Drug Administration (FDA):

CFR 21, 173.310, ... Boiler Water Additives Permitted in Plants Where Steam Contacts Food

H. Environmental Protection Agency (EPA):

CFR 40, PART 60, Appendix A, Method 9, Visual Determination of the Opacity of Emissions from Stationary Sources

PART 2 - PRODUCTS

2.1 D-TYPE WATER TUBE BOILER

A. Factory-assembled, packaged water tube, industrial-class, high pressure steam boiler. Two drum, "D-type" furnace tube configuration, two pass. Designed for natural gas and fuel oil firing.

B. Service: Designed to continuously receive feedwater at 100 °C (212 °F) and generate steam at pressures and quantities shown.

C. Performance:

1. Steam output quantity, refer to drawings.
2. Steam output quality, 99 percent minimum at all steam flow rates. Based on water quality in boiler of 3500-ppm maximum total solids, 15-ppm maximum suspended solids, 700-ppm maximum alkalinity.
3. Minimum Efficiency at Required Maximum Output:
   a. Natural Gas Fuel (37.3 MJ/cubic meter) (1000 Btu/cubic foot): 78 percent at 15 percent excess air or 80 percent at 5 percent excess air.
   b. Fuel Oil (ASTM D396 Grade 2, or amber): 83 percent at 15 percent excess air or 81.5 percent at 5 percent excess air.

D. Boiler Heating Surface and Furnace Volume:

1. Heating Surface Area: Provide surface area necessary to obtain required performance, however surface area shall not be less than shown on the drawings. Heating surface is defined as flat projected tube surface, including fins, in combustion space, whether or not covered by refractory, plus outside (gas side) circumferential area of all convection tubes.

E. Minimum Design Pressure, 1375 kPa (200 psi).

F. Construction:

1. Codes; Comply with ASME Boiler and Pressure Vessel Code, Sections I, II, VII, and IX.
2. Design shall accommodate thermal expansion and seismic shocks (in seismic areas).
3. No element of the boiler or accessories shall be overstressed, displaced, or have cracks, broken welds or excessive deflection. All vertical elements of the boiler and accessories shall be plumb and all horizontal elements shall be level.
4. Base Frame: Design for mounting on flat concrete base. All elements shall be level and square. Provide attachments for anchorage to concrete foundation.
5. Provide lifting lugs and jacking pads.
6. Drums:
   a. Steam drum shall be minimum 914 mm (36-inch) diameter. Bottom drum shall be minimum 610 mm (24-inch) diameter. Equip steam drum with elliptical side-hinged manway on each end. Equip bottom drum with non-hinged elliptical manways at each end. Equip all manways with properly fitted forged steel yokes, bolts, nuts, and non-

asbestos gaskets. Manway covers shall have bolt slots forged integral with covers. Provide access to all manways clear of piping, valves.

b. All tube holes shall be grooved and sized for 50 mm (2 inch) tubes and shall be radial and properly located to permit proper alignment of tubes. Swaged tubes with reduced drum openings will not be permitted.

c. Intermediate header for water wall or convection tubes will not be permitted.

7. Drum Piping Connections:

   a. Flanged, except threaded are permitted for pipe size under 65 mm (2-1/2 inches).
   b. Steam nozzle shall be 2050 kPa (300 psi) ANSI flanged. Design nozzle and drum assembly to withstand forces and moments imposed by connected piping. Studding nozzle will not be permitted.
   c. Locate boiler manual steam vent to permit access to gate valve from platform located above boiler.
   d. Soot blower outlets.
   e. Locate safety valve outlets to permit straight run of vents through roof and to permit valve handle access from platform located above boiler.
   f. Separate connections for water column and auxiliary low water cutoff.
   g. Connections for boiler feedwater, chemical admission, combined continuous blow down and water sampling. Locate as shown on the drawings.
   h. Bottom drum blowoff.
   i. Water level sensor connections (for incoming feedwater control).
   j. Pressure gage and pressure switch connections.
   k. Two 50 mm (2 inch) piping connections on rear head of bottom drum for steam heater for keeping boiler warm in standby mode. Also, connection for temperature sensor for temperature control valve.

8. Drum Internals:

   a. Steam purification equipment, including dry pan separators, plate-type baffles and other devices as necessary, to meet steam quality requirements and provide proper water levels in the boiler steam drum.
   b. Boiler feedwater admission system to properly distribute feedwater.
   c. Chemical feed piping to permit infusion of mixture of water treatment compounds along entire length of drum by continuous feed system.
   d. Continuous blowdown and water sampling system as combined unit designed to collect water along entire length of drum.
   e. Bottom drum blowoff system to properly collect sediment from bottom drum and to permit complete collection of sediment and drainage.
   f. Steam heating pipes in bottom drum to keep boiler warm on standby. Cap for future connections of steam supply and condensate return.

g. Drum internal fittings shall be provided, securely mounted and easily removable for boiler internal access for inspections and cleaning.

9. Tubes:

a. ASTM A178 Grade A, seamless or electric resistance welded, outside diameter 50 mm (2 inch) or greater. Uniform internal area, not swaged at drum connections, bend radii permitting turbine cleaning by mechanical tube cleaner.

b. Arrange convection tubes in alternate narrow and wide rows to permit tube removal without removing adjacent tubes. Align tubes to prevent impingement of soot blower steam jet directly on tube surface.

c. Front furnace tubes (if provided) shall be completely clear of burner throat and bullring and arranged to permit maintenance of front wall refractory system without tube removal.

d. Provide rear water wall tubes covering a minimum of 80 percent of the rear wall area. Arrange tubes to permit unobstructed view through observation ports in the rear wall and to permit maintenance of rear wall refractory without removing tubes.

e. Tubes separating the furnace from the convection area shall have continuous fins welded to each side of the tubes and to each other to form a pressure-tight membrane wall to prevent flue gas bypass of the furnace and convection spaces.

f. Soot blower and baffle supports from tubes shall be properly arranged to eliminate excessive stress on tubes.

10. Refractory:

a. Refractory quality and temperature characteristics shall be suitable for long-term service at the maximum operating conditions and shall be the boiler manufacturer’s experience-proven selection. Incorporate refractory systems in the front and rear walls, and seal interface between combustion and convection areas. Repair and replacement of refractory shall be possible without alteration to pressure parts of boiler.

b. Front and Rear Walls: Construct of shiplap firebrick arranged to permit expansion and contraction. Do not use castable refractory except to seal locations where bricks cannot be used. Provide bullring constructed of firebrick to protect burner throat refractory from forces generated within front wall. Provide expansion joint between bullring and burner throat. Incorporate openings in rear wall for observation ports, and for access to furnace as specified under paragraph "Casing." Access opening shall include a removable refractory plug.

c. Burner throat shall be refractory free.

11. Casing, Setting and Insulation:

a. Provide double wall casing system with insulation between the walls. Inner casing can be a welded finned-tube inner wall. The inner casing or welded fin tube construction shall be sealed to prevent the combustion gases from coming in contact with the outer casing.

b. Design casing at the combustion gas outlet to receive approved stack or breeching transition section as shown. Refer to plans for details of gas outlet arrangement.

c. Provide furnace access door located near the furnace floor. Use of burner throat as access is not permitted. Equip furnace access door opening with refractory, backed up by insulation and airtight cover system.

d. Provide three 50 mm (2 inch) diameter observation ports in rear wall of furnace located to permit observation of each sidewall of furnace and full area of burner throat and bullring. Furnish each port with clear and tinted interchangeable glass; gas tight sliding metal closure between glass and furnace, forced air-cooling.

e. Provide convection space inspection openings sealed with caps removable for inspection.

f. Insulation shall be manufacturer's proven standard materials and methods. No part of the external casing (except for areas within one foot of a casing penetration) shall reach a temperature exceeding 30 °C (86 °F) above ambient. Field-repair hot spots exceeding requirements.

g. Provide water wash troughs and drains (piped to accessible point) on both sides of lower drum to allow cleaning of exterior of convection tubes.

G. Factory Inspection and Tests:

1. Pressure Vessel Inspection and Certification: Inspect and certify the completed boiler assembly in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section I. Submit four copies of completed ASME Form P-3 for each boiler.

2. Inner Casing Pressure Test: Perform test after erection of the boiler pressure parts and inner casing. Seal boiler openings air-tight and pressurize the furnace and convection area to 2.5 kPa (10-inches of water) minimum. Check all welded joints with soap solution. Seal all leaks by rewelding. The inner casing shall be assumed to be tight when it holds pressure for 10 minutes with a loss not exceeding 10 percent. Test shall be certified by manufacturer and may be witnessed by a Government representative.

H. Finish: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer as specified in Section 09 91 00, PAINTING.

2.2 BOILER TRIM (ACCESSORIES):

A. Conform to ASME Boiler and Pressure Vessel Code, Section I. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT, for operation of water level and steam pressure controls.

B. Soot Blowers: Provide one or more systems on each boiler that burns oil as primary or secondary fuel. Arrange the system to completely clean the convection area.

1. Type: Steam-operated, valve-in-head, chain-operated to control rotation of element and admission of steam.

2. Elements: Equip with venturi nozzles located to clean all tubes without damaging impingement on any tube as evidenced by tube surface erosion. Provide materials that meet temperature gradient characteristics of the boiler/element arrangement. All materials in the element shall be selected and certified as having temperature characteristics in excess of temperature requirements.
3. Heads: Located in front or rear, as necessary to allow removal of element or as shown, securely mounted and structurally supported to prevent binding in operation. Equip heads with liquid-filled pressure gage of proper scale to check soot blower operation. Provide purging air from burner wind box to soot blower elements.
4. Bearings: Shall support the element without bending, binding or distortion, and shall be mounted in boiler convection space in manufacturer's standard and approved method.

C. Steam Safety Valves:
1. Provide two or three on each boiler. Capacities certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
2. Type: Angle pattern, flanged or threaded inlet, flanged or threaded side outlet, lifting lever, bronze or cast iron bodies, stainless steel trim, dual control rings. Valves with bronze bodies shall have EPDM O-ring seat seals. Valves with cast iron bodies shall have lapped seats.
3. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Set pressures as shown. Lowest set pressure shall not exceed normal operating pressure by more than 210 kPa (30 psi). Provide 30 kPa (5 psi) difference in setting between each of the valves.

D. Steam Pressure Gage:
1. Construction:
   a. Case: Surface-mounting, bottom or back connection, threaded ring, blowout disc in rear.
   b. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
   c. Measuring Element: Bourdon tube designed for steam service.
   d. Movement: Stainless steel, rotary.
   e. Pointer: Micrometer adjustable, black color.
   f. Window: Laminated safety glass, or plastic.
2. Accuracy: Full span, 1/2 percent.
3. Range: 0 – 1200 kPa 0 – 160 psi.
4. Installation: Stop valve, steel piping, valved blowdown, siphon, union at gage, valved connection for inspector's gage. Mount gage on sheet metal panel affixed to front of boiler. Use spacers between panel and gage to permit operation of blow-out disc.

E. Water Column with Water Level Indicator:
1. Type: Conductivity probe type water level sensing, tilted prismatic gage glass with illumination, 1725 kPa (250 psi) steam minimum design.

2. Conductivity Probes: Stainless steel with virgin Teflon insulation, AC power. High water alarm, low water alarm, primary low water cutoff, grounding probe. Low water alarm point higher than low water cutoffs. High and low alarms operate bell and warning lamp on boiler control panel but do not cause a burner shutdown.
3. Gage Glass - Prismatic: Single or double (offset) tilted prismatic tempered borosilicate reflex units of sufficient length to include all low water cutoff points and high water alarm point without discontinuity. Provide gage illuminator, mounted vertically, designed to direct light at gage only. Locate in front of gage. Do not block view of gage from personnel standing 1800 mm (6 feet) in front of burner. Provide chain-operated 1/4 turn gage valves. Extend chains to within 1800 mm (6 feet) of the floor.

F. Auxiliary Low Water Cutoff:
1. Type: Float chamber with float-actuated sealed snap switch. Water piping connections to the steam drum shall be independent from other devices such as the water column.
2. Construction:
   a. UL listed.
   b. Float chamber shall have drain connection.
   c. Packless construction with pivot and bearing point remote from high temperature areas.
   d. Design for 1725 kPa (250 psi) steam.

G. Low Water Cutoff Shunt Switches: Provide two separate non-latching pushbutton controls, one to short-circuit probe-type primary low water cutoff and the second to short-circuit the auxiliary low water cutoff when each is blown down. Locate pushbuttons within reach of drain valves for cutoffs.

H. High Steam Pressure Cutouts:
1. Provide two units with different set points. Unit with lowest set point shall be automatic reset; unit with highest set point shall be manual reset.
2. Type: Bellows actuated sealed snap-acting or mercury switch with adjustable set point and adjustable differential pressure (automatic reset unit).
3. Construction:
   a. UL listed.
   b. Design for 1375 kPa (200 psi) minimum emergency pressure.
   c. Switch position indicator visible without removing cover.
   d. Set pressure range: To 110 percent of required set pressure.
   e. Provide set point indicators with graduated scales for set point and differential pressure that are visible without removing cover.
4. Mounting: Pipe directly to boiler steam drum or to water column. There shall be no valves between cutouts and steam drum. Provide siphons at each switch to protect bellows from high temperature.
5. Set Points:
   a. Automatic Reset Unit: Refer to boiler schedule shown on the drawings.

b. Manual Reset Unit: 35 kPa (5 psi) higher than automatic reset cutout but below safety valve set pressure. Subtractive differential not to exceed 70 kPa (10 psi).

I. Feedwater Control Valve:

1. Type: Single-seated, cage guided, balanced valve plug, or characterized rotary valve, designed for throttling service. Equal-percent valve flow characteristic. Electric actuator with positioner.
2. Performance: Refer to schedules on drawings for pressure, temperature and flow requirements. If not scheduled, flow capacity shall be 125% of maximum boiler steam flow with a maximum pressure drop of 35 kPa (5 psi). Maximum seat leakage at shut-off shall not exceed 0.01% of maximum valve capacity (FCI 70-2, Class IV).
3. Construction – Plug Type:
   a. Body Type: Cast iron or bronze, flanged for 65 mm (2-1/2 inch) pipe size and larger, threaded for 50 mm (2 inch) pipe size and under, rated for 1725 kPa, 138 °C (250 psi, 280 °F) minimum.
   b. Plug, Cage, Seat Ring: Replaceable, hardened stainless steel.
4. Construction – Rotary Type:
   a. Three-piece body, cast steel or bronze, flanged for 65 mm (2-1/2 inch) pipe size and larger, threaded for 50 mm (2 inch) pipe size and under, rated for 1725 kPa, 138 °C (250 psi, 280 °F) minimum.
   b. 316 SS ball and stem, Polyfil seat, TFE coated SS seal.
5. Valve Sound Levels: Conform to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
6. Actuators and Controllers: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

2.3 BURNER AND FUEL TRAINS:

A. Burner Type: Combination natural gas and fuel oil, packaged, forced draft, single burner, modulating firing, register type on D-type boilers ,variable speed forced draft fan. Interrupted igniter (pilot), electrically ignited, natural gas and propane. Design for low excess air operation, fiber mesh burner construction is not acceptable. Design burner for low NOx emissions.

1. Gas Burner: Ring type with multiple ports and spuds, or spud type.
2. Oil Burner: Gun type, inside mix, steam or low pressure air atomizing.
3. Igniter (Pilot): Interrupted, electrically ignited, natural and LP (propane) gas.

B. Service:

1. Continuous long term operation at all firing rates on each fuel listed under PROJECT CONDITIONS in Part 1. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures and heating values.

2. Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures, atomizing media trains or pressures.
3. Igniter (Pilot) Fuels: Normal fuel will be natural gas. Propane will be used if there is an interruption in natural gas service.

C. Performance:

1. Igniter (pilot) flame on natural gas and propane shall form close to the point of ignition and shall be stable. Ignite both the gas and oil burner with single igniter.
2. Main flame on gas and oil fuels shall ignite at lowest firing rate.
3. Main flame characteristics at all firing rates:
    a. Flame retained within 150 mm (6 inches) of diffuser.
    b. Flame stable with no blowoff from the burner or flashback into the burner. No pulsations.
    c. Throat refractory shall be sufficiently heated to provide stable flame on gas firing.
    d. No deposits of unburned fuel or carbon at any location.
    e. No carryover of flame beyond the end of the first pass (furnace).
    f. Flame impingement on furnace tubes or refractory is not permitted if it results in hard carbonaceous deposits on furnace tubes or refractory or excessive emissions in the flue gas, or failure of furnace tubes, or deterioration of refractory.
4. Main Burner Operation:
    a. Minimum turndown 4/1 .
    b. Single point Jack-shaft control for fuel, air and flue gas recirculation is not acceptable.
    c. Operate at all loads on any one fuel without any manual changes to burners, fuel or atomizing media trains or pressures, air train.
    d. Excess Air in Flue Gases with Oxygen Trim at Null Position:

Boiler Steam Output, Percent of Maximum Required Capacity	Percent Excess Air Allowable Range
Below 25	15 minimum
25 – 39	15 – 35
40 – 100	15 – 25

e. Excess Air in Flue Gases (Low Excess Air Burners) with Oxygen Trim at Null Position:

Boiler Steam Output Percent of Maximum required Capacity	Percent Excess Air Allowable Range
Below 20	10 minimum
20 – 39	5 - 15
40 – 100	5 - 10

f. Performance at any load point shall be repeatable after increasing or decreasing the firing rate. Repeatability plus or minus two percent excess air, at 20 percent and higher boiler loading except excess air must remain within ranges specified above.

5. Oxygen trim control set at maximum position shall not blow out the fire at any load point. At minimum position, the combustion shall not go below stoichiometric.

6. Oil Atomization: If plant is cold (no steam available), and if steam-atomizing burners are provided, light-off shall be with compressed air atomization media supplied by boiler's compressor. Boiler shall operate with combustion controls on "manual" and continuously generate at least 13 percent of the maximum rated steam flow with input compressed air at 550 kPa (80 psi) and a maximum of 0.8 standard cubic meters per minute (30 SCFM).

7. Noise and Vibration: Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan and oil atomization system. Burners shall operate without pulsation.

D. Flue Gas Emissions Limits:

1. Carbon Monoxide: Shall not exceed 100 PPM.
2. Smoke: On natural gas and No. 2 oil shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale. 3. NOx: 9 ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas. 40 ppm maximum, corrected to 3 percent oxygen, dry basis on low nitrogen No. 2 fuel oil.

E. Burner Design, Construction and Arrangement:

1. Burner Access (Main Burner and Igniter): Arrange fuel trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
2. Arrangement of Fuel Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not mount any piping or devices within 600 mm (2 feet) of boiler side and top casings, and do not attach any piping or devices to boiler casings.
3. Coatings: Provide surface preparation, heat resistant prime and finish coats using standard color of boiler manufacturer. Refer to Section 09 91 00, PAINTING.
4. Combustion Air System and Flue Gas Recirculation (FGR) System (if provided):

a. Air flow rates controlled by forced draft fan inlet or outlet dampers and variable speed drive.

b. Symmetrical, balanced distribution of combustion air into the burner.

c. Provide induced type flue gas recirculation (FGR) system if FGR is necessary to achieve specified NOx limits. All FGR ductwork shall comply with Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS.

d. Forced Draft Fan: Airfoil or backwardly inclined wheel, electric motor driven. Design for required excess air and for static pressure that is based on losses from fan inlet to stack or chimney outlet, including economizer (if provided), at jobsite altitude. Fan shall have no resonant frequencies at all operating speeds.

e. Motor: TEFC or open drip proof, non-overloading under all fan operating conditions, design for 40 °C ambient, premium efficiency type. Motors for variable speed service shall be rated inverter-ready. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

f. Damper: Design to provide accurate control of excess air with minimum hysteresis. On variable speed systems, the damper shall control only at lower firing rates.

g. Motor Starter Panel: Provide motor starter and variable speed drive mounted in NEMA 1 enclosure, readily accessible. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT, for burner management system motor power interlocks.

h. Sound Attenuators: Provide attenuators on forced draft air intakes to reduce sound levels to allowable limits. Refer to Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

5. Provide viewport, with one clear and one tinted replaceable interchangeable glass. Locate to permit view of main and igniter flames.

6. Burner Throat: Refractory tile, shaped to promote proper combustion, arranged with provisions for expansion and contraction and rated by the refractory manufacturer for the maximum service conditions.

7. Electrical Conduit: Provide liquid-tight flexible metal conduit with sealing fittings for all power and control services to fuel trains and burners. Refer to Section 26 05 33, RACEWAY and BOXES FOR ELECTRICAL SYSTEMS.

8. Factory Testing (Factory-Assembled Boilers): Mount burner and controls on boiler at factory and fire-test at all load points.

F. Natural Gas Main Fuel Valve and Piping Train:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description: Starting at the entrance to the train, the devices are, in sequence: plug valve, filter, pressure gage, pressure regulator, valved connection to pilot burner fuel train, flow meter, pressure gage, low pressure switch, two automatic safety shut off valves, valved leak test, high pressure switch, fuel flow control valve, plug valve, pressure gage, burner. Provide tee connection for vent between the automatic safety shut off valves. Vent line shall include valved leak test connection, automatic vent valve, valved leak test connection,

lockable plug valve, vent thru roof. High and low pressure switches shall be located to sense the constant pressure controlled by the burner pressure regulator and not the variable burner pressure.

2. Pressure Regulator:
    a. Type: Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.
    b. Service: Provide precisely controlled downstream pressure in fuel train, with upstream pressure as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lock-up pressure of the nearest upstream pressure regulator. Purpose of high performance regulator is to provide more accurate flow control and thus greater burner efficiency and to allow set points of high and low gas pressure switches to be closer to the normal operating pressure.
    c. Performance: Coordinate with burner requirements. Lock-up pressure shall not exceed 1.5 times regulated pressure. Coordinate speed of response with opening and closing time of automatic safety shut-off valves so that controlled pressure will be maintained during the opening and closing of the safety shut-off valves. The outlet pressure droop from low fire to high fire shall not exceed 5 percent of the set pressure.
    d. Construction, Main Valve: Cast iron body, replaceable plug and seat.
3. Automatic Safety Shut-Off Valves:
    a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
    b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
    c. Performance: Timed opening of six seconds or less to safely and smoothly ignite main flame, and close within one second.
    d. Construction: Valves 65 mm (2-1/2 inches) and larger, flanged ends; valves 50 mm (2 inches) and below threaded ends; position indicator showing open and shut, visible from front or side of boiler. Aluminum seating surfaces not permitted. Proof of closure interlock switch on each valve. Proof of closure electrical circuit shall include non-latching push button interrupter for testing the circuit. Valved leak test fittings before and after each valve.
    e. Approval: FM approved, UL listed for burner service.
    f. Proof of Closure Test: Provide non-latching push button control in the proof of closure circuit to interrupt the circuit for testing.

4. Automatic Vent Valve:
   a. Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.
   b. Service: Provide open-shut control of vent line that is connected between the two safety shut-off valves. Valves shall shut bubble-tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators. Valve shall be open whenever safety shut-off valves are closed.
   c. Approval: UL listed for burner service.
5. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
6. Pressure Switches: Refer to the article on burner management system in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
7. Fuel Flow Control Valve:
   a. Type: Throttling, controlled by combustion control system (Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT). Valve with adjustable characterization cam required on single point positioning control systems.
   b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Static pressure rating shall exceed the lockup pressure of the boiler-mounted regulator.
   c. Construction: If provided, characterization cam shall be shaped by at least twelve adjustment screws.
8. Pressure Gages, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

G. Fuel Oil Valve and Piping Train:
1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Starting at the entrance to the train, the devices are, in order: manual shut off valve, filter, pressure gage, pressure regulator, low pressure switch, high pressure switch, meter, oil flow control valve, thermometer, valved drain, automatic safety shut off valve, valved leak test, automatic safety shut off valve, valved leak test, manual shut off valve, pressure gage, burner.
2. Filter: Permanent edge-type elements, cleanable by rotation of a handle without interruption of flow. Filter element spacing 0.1 mm (0.0035 inch). Pressure rating shall exceed upstream safety relief valve set pressure plus accumulation. Maximum pressure loss 20 kPa (3 psi) at high fire. Provide plugged drain. Temperature rating 120 °C (250 °F) on heated oil service.
3. Automatic Safety Shut-Off Valves:

a. Type: Motorized-opening, spring closing, controlled by burner control system. Two 2-way valves required on No. 2 oil service; one 3-way and one 2-way required on heated oil service.
b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble-tight and be suitable for operation with upstream pressure exceeding upstream safety relief valve set pressure plus accumulation. Temperature rating 250 °F on heated oil service.
c. Performance: Timed opening of eight seconds or less to safely and smoothly ignite oil burner, one-second closure.
d. Construction: Threaded ends, valve position indicator visible from front or side of boiler. Proof of closure interlock switch on each valve. Provide non-latching push button switch in proof of closure circuit to interrupt circuit for testing.
e. Approval: FM approved, UL listed for burner service.
f. Provide 9.5 mm (3/8 inch) relief valve on piping between safety shut-off valves, 1375 kPa (200 psi) rating, tight shut-off. Set pressure lower than pressure rating of safety shut-off valves. Provide valved leak-test connections between the two safety shut off valves and after the second safety shut off valve.

4. Pressure Switches: Refer to the article on burner management system in Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT. Set points shall be as required by the burner manufacturer. If there are no requirements, the set points shall be within 50% of the controlled pressure.
5. Fuel Flow Control Valve:
   a. Type: Throttling, controlled by combustion control system (Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT). Valve with adjustable characterization cam required for single point positioning control systems.
   b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Pressure rating shall exceed oil pump safety relief valve pressure setting plus accumulation.
   c. Construction: characterization cam shall be shaped by at least twelve adjustment screws.
   d. Burner manufacturer's standard fuel flow control system may be utilized for single point positioning systems if it has an adjustable characterization feature equal to the flow control valve specified.
6. Oil Guns and Nozzles: On steam atomizing systems, provide two special nozzles if necessary for cold start on compressed air atomization. Provide special guns if nozzles do not fit guns furnished for steam atomizing nozzles.
7. Provide oil pump arranged and piped to provide automatic drainage of oil gun when burner is shut down manually. Not required when oil gun is less than 600 mm (2 feet) long.
8. Pressure Gages, Thermometers, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

9. Boiler/Burner-Mounted Oil Pump and Relief Valve: Do not provide. House pumps are provided that include relief valves.

H. Steam Atomizing Valve and Piping Train (with Compressed Air for Cold Start):

1. Steam/Air Selection: Provide flexible hose or three-way valve to permit selection of steam or compressed air. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS. Hose connections or three-way valve shall be within 1800 mm (6 feet) of the floor.
2. Differential Pressure Control Valve:
    a. Type: Spring loaded, diaphragm-actuated, controlled by oil pressure at burner.
    b. Service: Provide control of steam or air pressure to the oil burner. Base valve size on steam and air pressure available at valve inlet. Valve body shall be rated for 1375 kPa (200 psi) steam pressure.
    c. Performance: As required by burner.
    d. Construction: Cast iron body, stainless steel trim, double stainless steel diaphragms with vented space between to separate oil and steam or air.
3. Pressure Switches: Refer to paragraphs on the burner control system under Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
4. Shut-Off Valve:
    a. Type: Motorized or solenoid opening, spring closing, controlled by burner control system.
    b. Service: Provide open-shut control of atomizing media flow to burner. If solenoid valve requires a minimum differential pressure for operation, coordinate pressure requirements with available pressures. Valve body shall be rated for 1025 kPa (150 psi) steam, dead-end shut-off.
    c. Approval: UL listed.

I. Low Pressure Air Atomizing System:

1. Complete system for each burner, furnished by burner manufacturer, including compressor and drive, air filter, after cooler, low pressure switch and all piping systems. Where compressor is driven by separate motor and coupling drive system, provide all equipment including motor, coupling, compressors, starter, wiring and protection.
2. Motor: Premium efficiency type. Refer to the Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
3. Motor Controls: Provide motor starter in NEMA 4 enclosure. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT, for burner management control interlock proving power supply to motor.
4. Shaft couplings: All metal, flexible.
5. Sound Attenuators: Provide compressor enclosure, air intake silencer, or other means to reduce sound levels to those required. Refer to the Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.

6. Pressure Gages and Pressure Switches: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

J. Igniter (Pilot) Fuel Valve and Piping Train, Burner and Ignition System:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description: Arrange the system to allow selection of either natural gas or propane for the ignition fuel. Provide separate piping with plug valve, pressure gage, filter and pressure regulator for natural gas and for propane. Connect to the main burner natural gas service downstream of the main burner pressure regulator. Join the natural gas and propane services by means of a three-way plug valve. Continue with one pipe line including a low pressure switch, pressure gage, automatic safety shut off valve, automatic vent, automatic safety shut off valve, igniter.
2. Filters: Replaceable elements, five micron or smaller particle retention. Static pressure capability two times the maximum lockup pressure of nearest upstream pressure regulator. Maximum pressure loss, at full flow, 1.3 kPa (5 inches water column). Provide unions for filter removal.
3. Pressure Regulators:
    a. Type: Single-seated, diaphragm-operated. Provide separate regulators for natural gas service and for LP gas service. (Refer to the schematic diagrams shown on the drawings).
    b. Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
    c. Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
    d. Construction: LP gas regulator must be designed for 1725 kPa (250 psi) maximum pressure.
4. Automatic Safety Shut-Off and Vent Valves:
    a. Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.
    b. Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 140 kPa (20 psi) differential at shut-off.
    c. Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
5. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position.

Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.

6. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to ultraviolet flame scanner from any position on its mounting.
7. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
8. Pressure Switch and Pressure Gages: Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

2.5 BURNER MANAGEMENT CONTROL (FLAME SAFEGUARD) SYSTEM AND ACCESSORIES:

A. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
B. Control Panel: Controls shall be mounted in free standing NEMA 4 enclosure. There shall be no power wiring in this enclosure.
C. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.

2.6 FLUE GAS ECONOMIZER:

A. Heat exchangers to transfer heat from boiler flue gases to boiler feedwater.
B. Type: Rectangular configuration, replaceable finned tubes, up flow flue gas, counter flow water, insulated casing with removable panels allowing access to all tubes for cleaning and replacement. Arrange tube to permit lane-type soot blowing.
C. Performance: Refer to schedules shown on the drawings. Coordinate input flue gas temperatures with data from boiler manufacturer.
D. Construction:
    1. Comply with ASME Boiler and Pressure Vessel Code, Section I. Design unit to permit operation with no water in the tubes at the temperature listed below.
    2. Design Pressure:
        a. Water tubes, 2050 kPa (300 psi) minimum.
        b. Inner casing, 2.5 kPa (10 inches water column) minimum.
    3. Design temperature 370 °C (700 °F) minimum.
    4. Tubes: Duplex stainless steel tubing. Helical-wound non-serrated Duplex stainless steel fins continuously welded to tubes. Headers of seamless carbon steel tubing, Schedule 40 minimum. 2050 kPa (300 psi) flanged piping connections. Gravity drainage. Return bend areas shall be exposed to the bulk temperature of the flue gas. Headers shall be external to the casing. Fin density shall not exceed 157 fins per meter (48 fins per foot). Maximum fin height 13 mm (0.5 inches).

5. Casing: Inner and outer casing with insulation between. 80 mm (3 inch) angle flanges on flue gas inlet and outlet for attachment of breeching and stack.
    a. Inner Casing, 3.5 mm (10 gage) thick Type 316 stainless steel, all welded. Stainless steel angles for breeching attachment to casing. Entire casing system must be gas tight.
    b. Insulation: Mineral fiber, ASTM C612, 50 mm (2 inches) thick.
    c. Outer Casing: Galvanized or painted steel, 0.4 mm (27 gage) thick.
    d. Access and Inspection Openings: Insulated, 400 mm (16 inches) square minimum.
6. Design to permit field replacement of tubes without removing unit from stack. Provide bolted access doors for tube replacement.

E. Accessories:
1. Safety Relief Valve: Valve designed for steam and water service, ASME - National Board certified, selected by economizer manufacturer in accordance with ASME Code requirements. Set pressure 1900 kPa (275 psi) gage.
2. Soot Blowers: Steam-operated, rotating valve-in-head. Provide sufficient number of blowers to clean all tube areas. Location, arrangement and quantity based on recommendations of soot blower manufacturer for type and size of economizer furnished. Soot blowing shall be lane-type.
3. Inlet and Outlet Transitions: Designed and furnished by economizer manufacturer.

F. Factory Test and Inspections: Inspect the completed economizer assembly in accordance with the ASME Boiler and Pressure Vessel Code, Section I. Certify the inspection and submit four copies of the completed ASME Form P-3 for each economizer.

2.4 TOOLS:

A. Oil Burner Vise and Wrenches: Deliver to the Contracting Officers Technical Representative (COTR)/Project Engineer (RE) for mounting by VA personnel. Furnish only if burner requires wrench not found in commercial hardware store.

B. Device for Hanging Oil Burner Guns: Space for total number of guns furnished. Deliver to the COTR/RE for mounting by VA personnel. Furnish only if oil gun must be removed from burner when firing gas.

2.8 SPARE PARTS

A. 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.

B. Boiler, Burner, Trim, Feedwater Control Valve:

1. Drum handhole gaskets, three complete sets for each boiler.
2. One clear lens and one tinted lens for each furnace and burner observation port on each boiler.
3. Sufficient glass inserts and gaskets to re-equip all water level gage glasses on one boiler.
4. One set of drive belts for each belt-driven apparatus on each boiler.
5. One gallon oil for burner-mounted atomizing air compressors.
6. If cast refractory plug is utilized for furnace access, provide sufficient refractory material to rebuild one plug for each boiler.
7. One set of all gaskets for each type of oil gun.
8. One oil gun and nozzle of each type and size utilized.
9. 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 and STEAM GENERATION.

B. Boiler, Burner and Economizer Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping.

C. Soot Blower Element Position: Adjust so that nozzles do not blow directly on tubes.

D. Drainage Facilities for Boiler Water Column, Gage Glass, Low Water Cutoffs, Water Level Alarms:

1. Refer to Articles, BOILER and BOILER TRIM. 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.

E. Boiler Drum Level Transmitter for Feedwater Regulator System:

1. Provide three-valve isolation and equalizing system rated for 1375 kPa (200 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.

F. Boiler Casing Flashing: Flash or seal all pipe penetrations in casing at steam drum to prevent leakage of water into boiler insulation.

G. Air and steam hose connections for selection of atomizing media shall be within 1800 mm (6 feet) of the floor.

3.2 CLEANING AND PROTECTION FROM CORROSION

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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 boilers from fireside and waterside corrosion at all times.
   2. Dry Storage: When the boilers are not filled with water, protect the watersides and firesides with a dry storage method recommended by either the boiler manufacturer or the ASME Code, Section VII.
   3. Wet Storage: If, after water is placed in the boilers, they are not fired for equipment adjustment or testing for more than two weeks, the boilers shall be protected with a wet storage method recommended either by the boiler manufacturer or the ASME Code, Section VII. If boilers are not fired for equipment adjustment and testing for more than one month, drain the boilers and place in dry storage.
   4. Chemical Treatment: The quality of the water in the boilers 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 Project 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. Refer to Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT for general requirements. 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 Boiler and Economizer (if provided) 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. Boiler, 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. Boiler External Piping (as defined by ASME B31.1, Power Piping):
    a. Refer to Section 23 21 11, BOILER 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. Burner Management Control (Flame Safeguard) System:

1. Demonstrate set points and operation of all control, interlock, monitoring and indicating functions. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
2. Prior to scheduling final test, submit certification that all control, indicating and interlock devices have been pretested (Refer to Section 23 08 11, DEMONSTRATIONS and TESTS FOR BOILER PLANT.

3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

F. Performance Testing of Boiler, Burner, Economizer, Combustion Control, Boiler Plant Instrumentation, Computer Workstation (if provided):

1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide the services of a testing firm to determine the NOx and carbon monoxide at boiler loads as required by the emissions authorities. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:
    a. Operate boiler on each fuel, with economizer (if provided) in service, and record data for at least six evenly spaced steam outputs between low fire start and 100 percent of full steam output, and in the same sequence back to low fire. Demonstrate performance required by paragraphs under the Article, BURNER AND FUEL TRAINS and ECONOMIZER in Part 2 and by boiler and economizer equipment list shown on the drawings.
    b. Demonstrate proper operation of combustion controls, draft controls, feedwater level controls, instrumentation and computer workstation programming (if provided). Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
    c. When flue gas oxygen trim is provided, conduct tests with trim control on manual at the zero trim (null) position. Refer to Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
4. Test No. P-2:
    a. Demonstrate sound level of burner system and atomizing air compressor.
    b. Test point shall be at pre-purge, and firing at 100 percent of maximum boiler load.
    c. Refer to sound level requirements in Section 23 05 51, NOISE and VIBRATION CONTROL FOR BOILER PLANT.
5. Test No. P-3:
    a. Check current draw of forced draft fan motor at pre-purge and at 100 percent of maximum boiler load with combustion air control at maximum position.
    b. Current draw shall not exceed full load current stamped on the motor nameplates.
    c. This test may be combined with Test No. P-1.
6. Test No. P-4: Operate boiler on both fuels, flue gas oxygen trim in service on automatic control, and record data at a minimum of 6 evenly spaced steam output points between low fire start and full steam output and in the same sequence back to low fire. Demonstrate oxygen trim control performance required by Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.
7. Test No. P-5: Operate boiler on one fuel, flue gas oxygen trim in service on automatic control, and record data at the following load points: Low fire start, 13, 20, 40, 60, 80, 100, 80, 60, 40,

20 and 13 percent of full steam output. Demonstrate oxygen trim control performance required by Section 23 09 11, INSTRUMENTATION and CONTROL FOR BOILER PLANT.

8. Test Methods:
   a. Utilize permanent instrumentation systems for data. All instrumentation systems and computer workstation shall be operational and in calibration.
   b. Provide portable thermocouple pyrometer furnished and retained by the Contractor to measure stack temperature as a verification of permanent stack temperature instrumentation.
   c. Use portable electronic flue gas analyzer furnished by Contractor to determine constituents of flue gas and stack temperature. Analyzer shall be capable of measuring oxygen in percent with accuracy of plus or minus 0.5 percent and carbon monoxide in parts per million (ppm) with accuracy of plus or minus 5 percent of reading (Range 0-1000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Instrument shall have been calibrated with certified test gases within three months prior to use and immediately after cell replacement.
   d. In Test Nos. P-1, 2 and 5 P, retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
   e. Steam loads for test may be furnished by the VA Medical Center hospital systems, by operation of the steam silencer vent system, or by a combination of the above. If variable hospital loads interfere with the testing, conduct tests at night or on weekends when the loads are more stable.
   f. Provide dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
   g. Smoke testing shall be by visual observation of the stack and by smoke density monitor (permanent instrument - if provided). If smoke density monitor is not provided, utilize Bacharach Model 21-7006 Smoke Test Kit. If there is disagreement with the results of these tests, provide qualified observation person and tests in compliance with EPA Reference Method 9 (CFR 40, Part 60, Appendix A).
   h. Sound level instruments will be Government furnished.
   i. 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.
9. Pretesting:
   a. Perform pretest at the final stage of the burner fine-tuning process.
   b. Prior to scheduling final test, submit evidence of pretest. Evidence shall consist of data sheet signed and dated by personnel representing burner manufacturer, combustion controls manufacturer, burner controls manufacturer.

c. Pretest data sheets shall list the following data for each fuel and each screw on the fuel flow valve characterization cam starting at the minimum position, proceeding to the maximum position and returning to the minimum position.

1) Fuel valve screw number or actuator position.
2) Steam flow rate (at minimum, 50 percent, maximum firing position only).
3) Steam pressure: At boiler drum, and at header (at minimum, 50 percent, maximum firing position only).
4) Fuel Pressures: At burner and also upstream of fuel flow control valve.
5) Fuel temperature (heated oil only).
6) Fuel flow rate.
7) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent and maximum firing positions only).
8) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).
9) Stack temperature: Boiler outlet, economizer outlet.
10) Flue gas oxygen and carbon monoxide (utilize instrument which has been calibrated with certified test gases).
11) Flue gas NOx (if limit specified).
12) Percent excess air.
13) Opacity of flue gas.
14) Submaster position.
15) Flame shape: Note and describe any flame contact with refractory or heating surface.
16) Combustion air temperature-dry bulb and wet bulb.
17) Barometric pressure (one reading).

d. Calibrate all pressure gages prior to the pretest.

G. Capacity - Efficiency Test of Boiler and Burner:

1. Perform test on one of each size boiler in the project, selected by RE, on all main burner fuels.
2. Test No. E-1: Test boiler on each fuel, with no water in economizer, at full load. Demonstrate performance required by paragraphs under the Article, BOILER in Part 2 and by boiler equipment list shown on the drawings.
3. Test Methods:

a. Conform to ASME Performance Test Code PTC 4.1. Use abbreviated input-output and heat balance methods. Utilize ASME Test Forms PTC 4.1-a, 4.1-b.

b. Test Meters and Instruments:

1) Feedwater Flow Meter: Vortex or turbine-type, totalizing in increments of 10 gallons or less, pressure rating exceeding feed pump no flow shut-off pressure, temperature rating exceeding normal feedwater temperature, calibrated immediately prior to test by independent laboratory. Calibrate at three points, ten percent above, ten percent

below, and at the required flow rate at high fire. Furnish calibration data. Remove meter from the line and deliver to RE after tests are accepted.

2) Fuel Oil Flow Meters: Displacement type, totalizing, smallest reading one liter (one gallon), pressure rating exceeding oil pump safety relief valve set pressure plus accumulation, 120 °C (250 °F) (if heated oil), calibrated immediately prior to test by independent laboratory. Calibrate at three points: Ten percent above, ten percent below, and at the required flow rate at high fire. Furnish calibration data. Remove meter from the line and deliver to RE after tests are accepted.
3) Natural Gas Flow Meter: Utilize permanent meter serving boiler plant.
4) Steam Calorimeter (for measuring steam quality): Throttling, U-path, temporary instrument, furnished and retained by Contractor, with thermometer that has been calibrated immediately prior to test. Provide one spare calibrated thermometer.
5) Portable electronic flue gas analyzer as specified for the performance testing.
6) Thermocouple Pyrometer (for measuring flue gas temperature): Temporary instrument furnished and retained by Contractor, 100 - 400 °C (200 - 800 °F) range, automatic ambient temperature compensation.
7) Thermometers: Utilize contractor-furnished and retained temporary thermometers and permanent thermometers to measure fuel and air temperatures. All must be calibrated immediately prior to test. Furnish calibration data.
8) Pressure Gages: Utilize permanent gages. Calibrate each gage immediately prior to test. Furnish calibration data.
9) Plant Instruments and Computer Work Station (if provided): Must be calibrated, programmed and in proper operation.

c. Fuel Analyses: The Government will furnish analysis of natural gas. The Contractor must obtain an ultimate type analysis of fuel oil prior to the final boiler tests. Fuel oil analysis must include heating value, specific gravity, viscosity and percent carbon, hydrogen, sulfur, ash, oxygen, and nitrogen. Test by independent laboratory.
d. Duration of each test will be four hours after all systems and measured parameters have stabilized.
e. Water quality in the boiler shall be checked immediately prior to the start of the tests. Solids and alkalinity must be adjusted prior to the test to conform to limits listed in Paragraph, BOILER in Part 2.

4. Pretesting: None required.

H. Internal Inspection of Pressure Parts and Furnace:

1. After all operational tests are satisfactorily completed, a Government retained licensed boiler inspector will determine if the boiler 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.
6. Hard carbonaceous deposits in the furnace are evidence of flame impingement. Within one year after acceptance of the boiler for Government operation, the Government will inspect the furnace for the carbonaceous deposits. If deposits are present, the Contractor shall remove them. If tubes or refractory are damaged, the Contractor shall replace them to achieve a like new condition. The Contractor shall make corrections to burners to eliminate the conditions that have caused the problems and shall provide complete retest of boiler and burner performance.

I. 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.

3.4 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 Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 each VA personnel responsible in the operation and maintenance of units.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

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Department of Veterans Affairs **VHA DIRECTIVE 2008-062**
Veterans Health Administration
Washington, DC 20420 **October 15, 2008**

BOILER PLANT OPERATIONS

1. PURPOSE: This Veterans Health Administration (VHA) Directive defines current VHA policy on the operation of boiler plants.

2. BACKGROUND

a. Without constant and vigilant care, equipment involving combustion or steam production under pressure, such as boilers and pressure vessels, can explode causing significant property damage, interrupt medical center operations and the provision of patient care, as well as injury and fatalities.

b. The boiler plant is essential to the operation of the medical center providing steam, heating, cooling and hot water required for sanitation, food production and preparation, infection control, and a healthful environment for the delivery of health care.

c. Boiler plant safety is dependent on: well-trained operators, supervised by a foreman or leader in boiler plant operations; properly-functioning safety equipment; proper operational procedures; well-maintained boilers and support equipment; and a commitment to continuous quality improvement. Fuel costs for the boilers are a significant portion of a medical center's utility expenditures. A recent review of 81 VHA boiler plants reported “every facility tested lacked proper safety devices, settings, or test procedures.”

3. POLICY: It is VHA policy that each boiler plant be operated in a safe and economical manner in compliance with Department of Veterans Affairs (VA) standards and directives and national codes, such as the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code and the National Fire Protection Association (NFPA) 85 Boiler and Combustion Systems Hazards Code.

4. ACTION: The facility Director, or qualified designee, is responsible for the safe and efficient operation of the boiler plant, and for ensuring that:

a. **There are Written Policies and Procedures.** Written policies and procedures are established (see Att. A).

b. **VHA Central Office is Notified, as Required**

(1) The Deputy Under Secretary for Health for Operations and Management and the Office of Construction and Facilities Management (OCFM) must be notified prior to the installation or replacement of high-pressure steam boilers (above 15 pounds per square inch gauge (psig) or greater); installation of new fuel burning equipment on existing boilers; and retubing 30 percent or more of a high-pressure steam boiler. Non-traditional and new technologies must be

reviewed prior to design and construction by OCFM, and approved by the Deputy Under Secretary for Health for Operations and Management Office. These include, but are not limited to:

(a) Oil filled boilers, and

(b) Low mass boilers.

(2) Unusual occurrences, such as a rupture or explosion of a boiler or pressure vessel; a furnace explosion; extensive damage from overheating; or any other unusual condition must be reported immediately to the Deputy Under Secretary for Health for Operations and Management and OCFM. ***NOTE:*** *Following the notification a thorough origin and cause analysis must be performed by the facility and a written report submitted as soon as possible.*

c. **On-Site Reserve Fuel Requirements are Maintained**

(1) Facilities firing coal as the main fuel normally store a sufficient supply of fuel to meet the normal demands of continuous operation for a period of 15 January days.

(2) Facilities firing oil as the main fuel must maintain a supply of fuel sufficient to meet the normal demands of continuous operation for a period of 15 January days. Plants that generate less than 50 percent of their annual steam demand by natural gas for 2 consecutive years are to be considered as burning oil only.

(3) Facilities firing natural gas as the main fuel with oil or propane back-up normally maintain a sufficient supply of back-up fuel to meet the normal demands of continuous operations for a period of 10 January days.

NOTE: *Where unusual conditions exist, the facility Director, or qualified designee, may authorize deviations from the storage quantity requirements. There must be a program of fuel testing and maintenance or replacement, to ensure that stored fuel remains suitable for burning.*

d. **Inspection and Testing are Effected Appropriately.** Fuel storage must be re-evaluated annually against actual fuel used in January. For other requirements see Attachment B.

e. **Compliance.** Compliance is assessed quarterly by each VA medical center, covered by the content of this Directive, completing the web-based survey, located on the Center for Engineering Occupational Safety and Health (CEOSH) Web site at: http://vaww.ceosh.med.va.gov/, no later than 2 weeks after the start of each fiscal quarter (October 1, January 1, April 1 and July 1). This survey requires certification by the Chief Engineer and the facility Director.

5. REFERENCES

a. NFPA 85, Boiler and Combustion Systems Hazard Code.

b. The Joint Commission, Management of the Environment of Care (EC) Standard .02.05.01.

c. Boiler Efficiency Improvement Operator Manual.

d. VHA Boiler Plant Safety Devices Testing Manual.

e. VHA Directive 7701.

f. VHA Handbook 7701.1

6. FOLLOW-UP RESPONSIBILITIES: The Director, Healthcare Engineering (10NB), is responsible for the contents of this Directive. Questions may be addressed to (202) 266-4604.

7. RESCISSION: VHA Directive 2003-050 is rescinded. This VHA Directive expires on October 31, 2013.

Michael J. Kussman, MD, MS, MACP
Under Secretary for Health

Attachments

DISTRIBUTION:	CO:	E-mailed 10/21/08
	FLD:	VISN, MA, DO, OC, OCRO, and 200 – E-mailed 10/21/08

ATTACHMENT A

GUIDELINES FOR BOILER PLANT OPERATIONS POLICIES AND PROCEDURES

1. <u>There Must be Written Policies and Procedures.</u> Written policies and procedures must be established, which at a minimum, must include:

a. A clear statement and definition of safety as the first priority for boiler plant operations. Boiler plant safety must not be compromised to maintain steam service.

b. A requirement that all safety devices installed in the boiler plant, or installed as part of the fuel systems, steam distribution systems and condensate return systems, must be periodically tested to ensure their proper function.

c. A system of notification so that no boiler safety device is recognized as non-functional without the facility Director's knowledge.

d. Testing procedures that are in accordance with the VHA Boiler Plant Safety Devices Testing Manual (available from vaww.ceosh.med.va.gov). Plant operators must be knowledgeable of the location, purpose, and proper function of all safety devices.

e. Ensurance that there is continuous operator attendance within boiler plants and other locations outside the boiler plant generating high pressure steam (above 15 pounds per square inch gauge (psig)). Boiler plant operators must not leave any high pressure (above 15 psig) boiler plant unattended at any time, nor can they be relieved by unqualified persons.

f. Ensurance that no boiler of any pressure can be restarted remotely.

g. An ongoing training program to develop, maintain, and regularly refresh operator proficiency in safe boiler plant operations to include documented formal and on the job training (OJT) for the specific equipment and operations at each medical center. OJT must be conducted and signed off on by the more experienced operators regardless of seniority. ***NOTE:*** *At a minimum, the Safe Steaming course should be completed by the entire Boiler Plant Staff.*

h. Ensurance that operators are well trained and proficient in properly performing the following:

(1) Lighting off, warming up, placing in service, and shutting down the boilers.

(2) Firing on each of the available fuels.

(3) Operating all plant equipment and controls, including start-up and shutdown.

(4) Gradual warm-up of hot piping systems and placing them into service.

(5) Maintaining water quality to protect the equipment and piping from damage.

(6) Handling malfunctions and emergency situations.

(7) Collecting and organizing the plant performance records.

(8) Routine equipment maintenance.

(9) Preparation of equipment for inspections.

(10) Facilitating and monitoring the receipt of fuels and supplies.

i. Operation of all equipment at the highest cost effectiveness and efficiency. This means maintaining steam pressure at the minimum necessary for the proper operation of the plant and connected loads.

j. A steam conservation program focused particularly on maintaining steam traps, condensate pumps, and the integrity of piping systems and pipe insulation. Steam and condensate leaks and other necessary repairs must be reported and given a high priority. This part of the written policy must include the following:

(1) The title and name of the person responsible for implementing and oversight of the program.

(2) The title and names of persons responsible for conducting the inspections.

(3) An inspection report format that includes the frequency of inspections; method and date of inspection; location of devices; types of devices or equipment; discrepancy found if any; and corrective action taken.

k. A steam load-shedding plan for implementation during a boiler plant emergency that reduces steam-generating capability, and identifies the critical loads that must continue to be served to the greatest extent possible, without compromising boiler plant safety.

l. Provisions that the emergency electrical generator serving the boiler plant is included as part of the medical center's emergency power supply system testing and maintenance program.

m. A water treatment program that includes daily tests, records of the tests, the use of chemicals, and a periodic review by a technical representative of the chemical supplier by an independent water treatment consultant, or a properly trained operator. No chemical treatment systems are to be manual. ***NOTE:*** *Magnetic water treatment systems <u>are prohibited</u> in VHA boiler plants.*

n. A utilities systems security program ensuring limited access to the boiler plant and on site fuel facilities, including fuel storage and piping systems.

o. A system for regular checking on the boiler plant operator during each shift to ensure that the ability to perform assigned duties has not been impaired due to an accident or other event; for example, radio or phone checks by Security Police or remote alarms that the operators must carry. ***NOTE:*** *One qualified boiler plant operator per shift is sufficient to attend gas-fired or oil-fired high-pressure boilers under normal circumstances.*

p. A requirement that each boiler operator have an annual physical examination to ensure physical fitness to perform assigned duties (see VA Handbook 5019, Pt. II).

q. An organizational structure that promotes continuous quality improvement in safe boiler operations.

r. A procedure for steam system shut down to allow maintenance to be performed.

s. Requirements that repairs to boilers and pressure vessels comply with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. No welded repairs are permitted except by certified welders using Code-approved procedures. The Boiler Plant must maintain records of certification, and the qualification of welders for a minimum of 3 years.

t. An equipment replacement program based on the following useful life expectancies. ***NOTE:*** *Retention of equipment beyond the useful life expectancy must be based on an engineering evaluation of the reliability, efficiency, and cost effectiveness of continued operation.*

Equipment	Useful Life Expectancy (in years)
(1) Fire tube boilers and burners	30
(2) Water tube boilers and burners	40
(3) Feed water Deaerator	30
(4) Economizers	15
(5) Burner management controls	20
(6) Combustion controls	20
(7) Instrumentation	20
(8) Boiler feed and condensate pumps	20
(9) Condensate and blow-off tanks and heat recovery	40
(10) Fuel oil pumps	40

(11) Fuel oil tanks	40
(12) Valves; shut off and control	20
(13) Water treatment equipment	20

2. <u>Required Documentation Must be Available to all Operators in the Boiler Plant.</u> This required documentation, which must be available to all operators in the boiler plant, must include:

a. **References.** These references must include the:

(1) One-line diagrams of boiler plant systems. High, Medium and Low Pressure Steam Systems, Make Up and Supply Water Systems, Condensate System, Primary and Alternate Fuel Systems, Control Systems, and the Electrical Distribution System.

(2) Manufacturer's literature of installed equipment.

(3) Boiler Efficiency Improvement Operator Manual.

(4) VHA Boiler Plant Safety Devices Testing Manual.

(5) Current VHA Boiler Plant Operations Directive.

(6) Current Medical Center Boiler Operations Policy.

(7) Current normal and emergency operations procedures, including: start-up, operating, and shut down of all boiler plant equipment, fuel systems, and steam distribution systems.

(8) Current list of connected equipment and their pressure and quantity requirements.

(i) Lock-out tag-out procedures for all equipment in the boiler plant.

(j) Confined space entry procedures, as applicable.

b. **Maintenance and Testing Records.** Maintenance and testing records must be retained for at least 3 years.

(1) All components of the utility system associated with the production and use of steam at the medical center, including fuel, must be individually reviewed for inclusion in the preventive maintenance program. All safety devices must be considered critical utility system components. Inspection, testing, and maintenance records are required for all critical components of the utility system.

(2) Records must include the:

(a) Date of test, inspection, or maintenance;

(b) Results of the test, inspection, and maintenance procedures accomplished;

(c) Parts installed;

(d) Names of individuals performing testing, inspection, or maintenance;

(e) Subsequent required notification of the Medical Center Director is made regarding any device failures; and

(f) Repairs or adjustments made to safety devices and the date of their return to service.

c. **Performance Data.** The performance data, which must be retained for at least 3 years, must include:

(1) Total steam production and fuel consumed (daily, monthly, and yearly).

(2) Daily outside temperature range.

(3) Make-up water quantity, and the percent of make-up in relation to amount of steam generated.

(4) Minimum and maximum steam demand per shift.

(5) Boiler efficiency based on steam output or fuel input (daily).

(6) Water treatment data, including all test reports and chemicals utilized.

(7) Boiler flue gas oxygen and stack temperature in relation to burner firing rate.

ATTACHMENT B

INSPECTION AND TESTING FOR BOILER PLANT OPERATIONS MUST BE EFFECTED APPROPRIATELY

Inspections and testing must be conducted in accordance with the following:

1. Qualified Testing Staff. A Qualified Inspector is an individual who is determined by the medical center's management to be qualified to inspect equipment by reason of training and experience. This is a very important determination. The required services must be procured from qualified individuals, if no VA staff is qualified.

a. Hydrostatic testing of boilers and pressure vessels must be conducted after a repair or a tube replacement, or when the boiler or pressure vessel integrity is in doubt. Hydrostatic pressure must be limited to 150 percent of normal operating pressure of the boiler or pressure vessel.

b. Selections of contractors for plant services including boiler inspections, burner adjustments, testing of safety devices, calibration of instruments, and monitoring of water treatment must be based on quality as the first priority. The contracting method chosen must allow contractors to be selected on the basis of qualifications as a first priority.

c. A Qualified Professional Inspector (QPI) is any one or combination of:

(1) A boiler inspector who has a valid commission from the National Board of Boiler and Pressure Vessel Inspectors.

(2) A boiler inspector who has qualified by passing a written examination under the laws, rules and regulations of a jurisdiction of the state.

(3) A boiler inspector who is regularly employed as a boiler inspector by a jurisdiction that has adopted and administers one or more sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code as a legal requirement, and has a representative serving as a member of the ASME Conference Committee.

(4) A boiler inspector who is regularly employed by an insurance company that has been licensed or registered by the appropriate authority of a state of the United States to write boiler and pressure vessel insurance.

2. Required Inspections and Operational Tests

a. **Key to Frequency Abbreviations**

(1) H = Hourly.

(2) D = Daily.

(3) M = Once per month.

(4) 6M = Once every 6 months.

(5) Y = Once per year.

(6) 6Y = Once every 6 years.

b. **Frequency Chart**

Item	**Frequency**
(1) High pressure boilers (above 15 psig): Inspect furnace and other internal surfaces, closures and accessories.	Y
(2) High pressure boilers (above 15 psig): Inspect exterior of Unit, casing, supports, closures, accessories, valves, controls.	Y
(3) Deaerator: Inspection and wet magnetic particle testing of welds of pressure vessel interior.	6Y
(4) Boiler fouling and combustion gas flow check.	Y
(5) Tube leak check.	Y

NOTE: *The items preceding (2b(1) through 2b(5) must be accomplished by a Qualified Professional Inspector. The following items (2b(6)) through 2b(13)) must be accomplished by a qualified individual as determined by the medical center's management. Such a determination must be carefully made for each item and each individual.*

Item	**Frequency**
(6) Low pressure boilers (15 psig and below): inspect interior and exterior, supports, closures, accessories, valves, and controls.	Y
(7) Deaerator: interior cleaning and visual inspection.	Y
(8) Adjust burner combustion settings and calibrate oxygen trim.	6M
(9) Check vibration of burner fans.	6M
(10) Calibrate instrumentation, monitoring, and control systems.	6M
(11) Calibrate pressure gages and thermometers.	Y

(l2) Operational Testing of Boiler Safety Devices, such as:

(a) Low-water cutoff (slow drain)	M
(b) Fire each boiler and the pilot on the alternate fuel for 1 hour	M
(c) Low-water cutoff shunt switch	M
(d) Auxiliary low-water cut-off (slow drain)	M
(e) Auxiliary low-water cut-off shunt switch	M
(f) High-water alarm	M
(g) Low-water alarm	M
(h) High-steam pressure cut-out (recycle)	6M
(i) High-steam pressure cut-out (non-recycle)	6M
(j) Steam safety valves (raise boiler pressure until valve pops)	6M
(k) Steam safety valves (accumulation test at high fire)	Y
(l) Flame scanner	M
(m) Check gas vent for leaks	6M
(n) High-gas fuel pressure cut-off	6M
(o) Low-gas fuel pressure cut-off	6M
(p) Gas fuel safety shut off valves proof of closure	6M
(q) Leak test gas fuel safety shut off valves	6M
(r) High-fuel oil temperature cut-off (heated fuel)	6M
(s) Low-fuel oil temperature cut-off (heated fuel)	6M
(t) Low-atomizing pressure for fuel oil	6M
(u) High-fuel oil pressure cut-off	6M
(v) Low-fuel oil pressure cut-off	6M

(w) Fuel oil safety shut off valves proof of closure	6M
(x) Leak test fuel oil safety shut off valves	6M
(y) Check operation of Liquid Petroleum Gas pilot	6M
(z) Low-pilot gas pressure cut-out	6M
(aa) Forced draft fan motor interlock	6M
(bb) Forced draft fan damper wide open for purge	6M
(cc) Boiler outlet damper wide open for purge	6M
(dd) Purge air flow interlock	6M
(ee) Timing for pre-purge	6M
(ff) Timing for post-purge	6M
(gg) Igniter timing	6M
(hh) Low fire position interlock	6M
(ii) Combustion air interlock	6M
(jj) Main flame out; i.e., time to close valves	6M
(kk) Ignition flame out; i.e., it is time to close valves	6M
(ll) Minimum igniter flame test	6M
(mm) Scanner not sensing ignition spark	6M
(nn) Low-oxygen alarm and/or cut-out	6M
(oo) Pre-purge setting of flue gas recirculation damper	6M
(pp) Interlock of building outside air damper with burner control	6M

NOTE: *The preceding safety devices are essential for ensuring the safest possible operation. Any boilers not so equipped must be immediately programmed for retrofit, with priority given to providing two low water cutoffs per boiler and two fuel safety shut off valves per fuel per boiler.*

Item	Frequency
(13) Boiler Plant Safety and Operational Duties	
(a) Overall plant operation	H
(b) Blowdown water columns	D
(c) Testing and adjusting water treatment	D
(d) Check furnace pressure	6M
(e) Check combustion gas leaks into boiler room	6M
(f) Clean waterside of boilers	Y
(g) Clean fireside and repair refractory	Y
(h) Operation of deaerator high and low water alarms	M
(i) Operation of deaerator steam pressure or temperature control	M
(j) Operation of condensate storage tank high and low water alarms	M
(k) Operation of all other alarm devices	M
(k) Operation of boiler economizers; temperatures in or out	D
(m) Review written procedures	6M

NOTE: *The inspection and testing schedule is required for boilers in service during the period. Boilers not in service must be inspected and tested prior to being placed in service. For boilers in service less than 3 months during the period, the schedule of inspections and tests performed by qualified technicians for burner-related functions may be extended, but is not to exceed 1 year.*

VHA Boiler Plant Safety Device Testing Manual
Third Edition

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1 INTRODUCTION

1.1 OBJECTIVE
The purpose of this manual used with manufacturers' manuals and design set points is to support the development of an individual boiler plant safety program for your specific boiler plant. The text presents a concise and thorough treatment of boiler safety as applied to automatically-fired gas and oil, heating and process boilers and boiler support equipment servicing healthcare facilities. The text includes a description of each boiler safety device, how it works, what its purpose is, and how to test the device. The safety devices are organized by categories in four chapters: Water Level Control, Pressure Containment, Fuel Train Safety Devices, and Burner and Air Train Safety Devices. A fifth chapter provides detailed step by step procedures for testing every device covered. This chapter can be used as a checklist and guide for safety testing. Some boilers will not include all of these devices.

The text does not replace existing standards. It succinctly states the main import of the standards. The final guide to safety should include all applicable standards. However, the testing envisioned in this text is far more rigorous than current industrial practice, even though the basic concept of this manual is that all boiler safety devices should consistently function properly. Proper function requires 1) proper installation, 2) proper calibration, and 3) proper activation. In situations that may arise where adherence to this manual would adversely affect the operation of the boiler, special authority may be requested to deviate from the manual through the Director, Health Care Engineering (10NB).

1.2 BACKGROUND INFORMATION
One must understand that the use of the term "boiler" may refer to the system that includes the generation, distribution, and use of steam. There are many safety devices such as level alarms, safety valves, relief valves, etc that are found on the components involved in the distribution and use of steam. The safety checks are necessary and must be conducted on **<u>all devices in the system</u>** in order to insure that the system is safe.

It is important that one has the manufacturer's manuals on all equipment to be tested before beginning the tests described herein. This is essential to know the manufacturer's recommended operating conditions, the wiring diagram, etc.

1.3 GENERAL OBSERVATIONS ON SAFETY TESTING

1.3.1 Items to be Checked on Any Interlock Device
Many safety devices utilize switches that actuate based on some set point to automatically alarm or shut the boiler off by shutting the two automatic fuel shut off valves. It is extremely important that one recognize that there are four attributes to such systems required for proper operation. These are:

- The switch must be in the right place.
- The switch must have the proper setpoint.
- The switch must activate at the proper setpoint.
- The switch must produce the desired effect.

All safety testing described in this text involving such switches centers around making sure that all these requirements are met. The most common failure in this regard is a failure to insure that the switch has the proper set point which requires measuring operating parameters in order to determine the proper set point.

1.3.2 Confirming That All Devices Actually Function for Intended Purpose
In testing any interlock device that operates through the automatic control system, it is paramount that the testing procedure verifies compliance with the four requirements listed above.

1.3.3 Lockable Valve Requirements
In order to facilitate testing of some types of interlock devices, it is sometimes convenient to temporarily isolate the interlock device and provide test ports by means of manual valves. However, these modifications cannot be allowed to increase risk by locking out a safety device during normal operation and should clearly indicate test and normal position. Any such manual valve that could isolate a safety device from its normal operating circuit should be lockable and the lock should be lockable **only** in the correct operating position.

1.3.4 Confirming That Jumpers Are Removed and Valves Properly Locked
In many cases in order to test a device, it will be necessary to either electrically jumper (bypass) a device or to valve out the device. The safety testing personnel should only carry a fixed number of jumpers and should make sure that at the end of a test that all jumpers being used are accounted for and that all lockable valves are locked in their correct position.

1.4 NOMENCLATURE

AFOSV	Automatic Fuel Oil Shutoff Valves
ALWCO	Auxiliary Low Water Cutoff
APFGSOV	Automatic Pilot Fuel Gas Shutoff Valves
APFGSVV	Automatic Pilot Fuel Gas Solenoid Vent Valve
CAPI	Control Air Pressure Interlock
CAPS	Combustion Air Pressure Switch
DA	Deaerator
DAODS	Deaerator Overflow Drain System
DASV	Deaerator Safety Valve
FDDWOPS	Forced Draft Damper Wide-Open Pre-Purge Proving Switch
FDMIS	Forced Draft Motor Interlock Switches
FGRDI	Flue Gas Recirculation Damper Interlock
AFGSOV	Automatic Fuel Gas Shutoff Valves and Solenoid Vent Valve
AFGSVV	Automatic Fuel Gas Shutoff Solenoid Vent Valve
FPI	Furnace Pressure Interlock
FSMFO	Flame Scanner-for main flame out
FSNSIS	Flame Scanner Not Sensing Igniter Spark
HFGPCS	High Fuel Gas Pressure Cutoff Switch
HFOPCS	High Fuel Oil Pressure Cutoff Switch
HWAB	High Water Alarm on Boiler
HWACT	High Water Alarm on Condensate Tank
HWADT	High Water Alarm on Deaerator Tank

IT	Igniter Timing
LAMDPS	Low Atomizing Media Differential Pressure Switch
LAMPS	Low Atomizing Media Pressure Switch
LFGOLI	Low Flue Gas Oxygen Level Interlock
LFGPCS	Low Fuel Gas Pressure Cutoff Switch
LFOPCS	Low Fuel Oil Pressure Cutoff Switch
LFPS	Low-Fire Proving Switch
LPFGPCS	Low Pilot Fuel Gas Pressure Cutoff Switch
LRVE	Liquid Relief Valve on Economizer
LRVOPS	Liquid Relief Valve on Oil Pump Set
LWA	Low Water Alarm
LWACT	Low Water Alarm on Condensate Tank
LWADT	Low Water Alarm on Deaerator Tank
LWCO	Low Water Cutoff
MFIT	Main Flame Ignition Timing
MV	Manual Valve
NRBSPLS	Non-Recycle Boiler Steam Pressure Limit Switch
OADI	Outside Air Damper Interlock
OBPS	Oil Burner Position Switch
OSDI	Outlet Stack Damper Interlock Switch
PAPS	Purge Airflow Proving Switch
POC_AFOSV	Proof of Closure on Automatic Fuel Oil Shutoff Valves
POC-AFGSOV	Proof of Closure on Automatic Fuel Shutoff Valves
PPT	Pre-Purge and Post-Purge Timing
PRV	Pressure Reducing Valve
RBSPLS	Recycle Boiler Steam Pressure Limit Switch
SVB	Steam Safety Valves on Boiler
SVFPRV	Safety Valve Following PRV
TP	Test Port

1.5 PREPARATION OF SYSTEM FOR SAFETY TESTING

The normal boiler installation does not generally allow easy access and control for testing. Safety testing is an ongoing activity for safe boiler plant operation. Modifications should be made to allow safe convenient testing. In this section a discussion is given of system modifications that will allow easy testing. The discussion is organized around classes of different safety devices. For detailed drawings illustrating a convenient test setup for each device, refer to the safety testing procedures given in the appendix.

1.5.1 Setup for testing a Steam Safety Valve Following a PRV

In order to test a safety valve following a PRV, a manual isolation valve should be installed downstream of the safety valve so that the valve can be tested without raising the pressure on the system downstream of the valve. (See Figure 1.1)

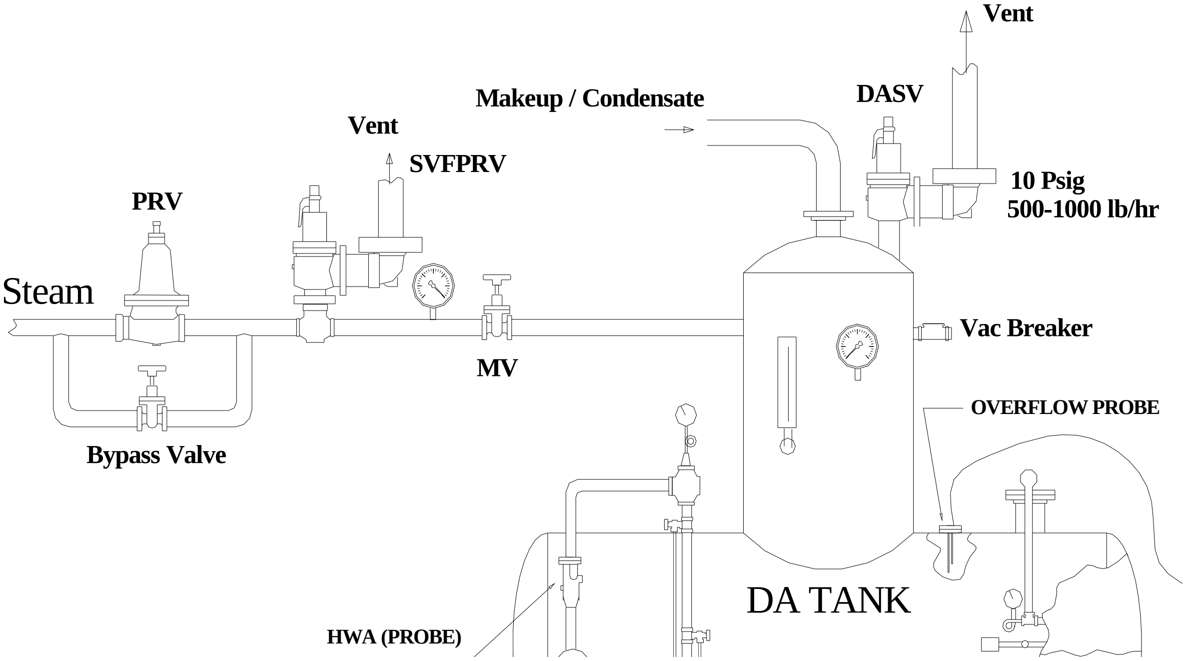


Figure 1.1 Safety Valve Following a PRV

1.5.2 Setup for testing a combustion air switch, purge air switch, furnace pressure switch, control air pressure switch, and high pressure switches for main gas and pilot.

In order to test these switches it is convenient to be able to temporarily isolate these switches from the normal pressure source and to apply test pressures that can be accurately measured. At the same time the piping should be such that the actual pressure that the switch senses can also be measured. The arrangement that is pictorially shown in Figure 1.2 for testing the combustion air pressure switch allows this objective to be met for all switches covered in this section.

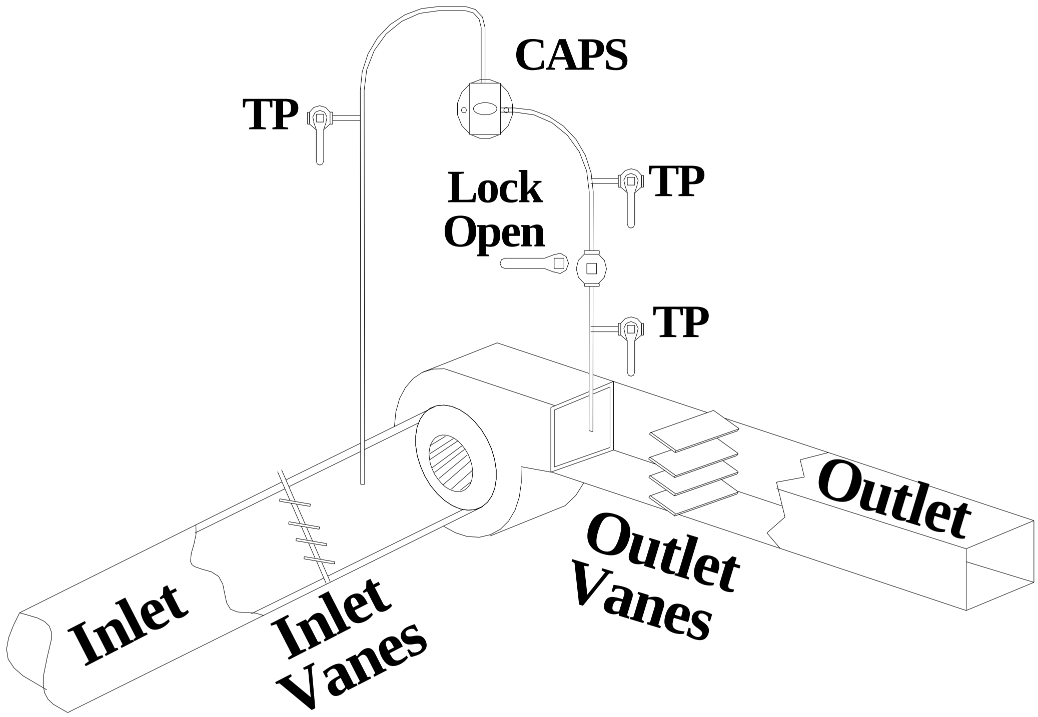


Figure 1.2 Air Pressure Switch

1.5.3 Setup for Leak Checking Oil and Gas Block Valves and Gas Bleed Vent Valve

In order to easily test for leaks in the block valves a test port (TP) and pressure gage must be available both in the line between the valves and downstream of the second valve. Also in the case of gas, a lockable manual valve downstream of the solenoid bleed vent valve is required. A port and pressure gage in the line between the solenoid valve and lockable manual valve is also needed. Note, there are two test ports (TP) for determining normal operating pressures and one test port (TP) for testing the isolated interlock. This arrangement is schematically shown for natural gas in Figure 1.3 and Figure 4.4 for oil fuel.

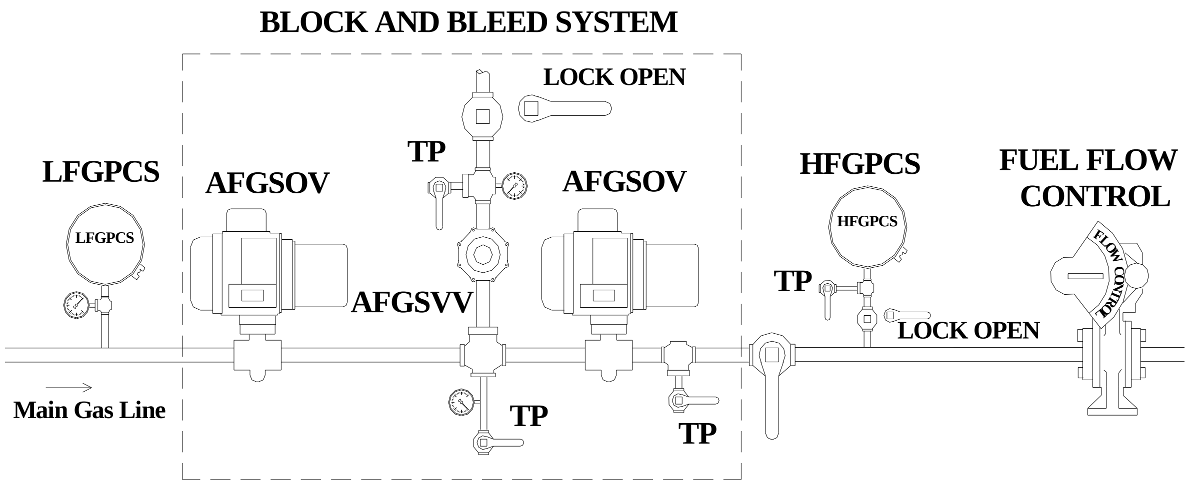


Figure 1.3 Leak Checking Automatic Shutoff Valves

1.5.4 Setup for Checking Dangerous Gas Detection System For the Building

Sample gas with a level of CO and combustibles slightly exceeding the sensor set points should be available with a means to supply the gas to the sensor per the manufacturers test procedures.

1.5.5 Setup for Checking the Deaerator Overflow System and Oil Liquid Relief Valve

A sight glass with turbine wheel should be installed downstream of the valve in order to visually confirm that flow exists. The oil liquid relief valve also requires a pressure gage at the pump discharge.

1.5.6 Setup for Checking Proof of Closure Switches, Low Fire Proving Switch, Force Draft Damper Vane Interlock, Outlet Stack Damper Interlock, Recycle Steam Pressure Switch, Non-recycle Pressure Switch, Primary Low Water Cutoff, and Recirculation Damper Interlock

It is necessary to electrically isolate these switches for testing. The two electrical leads from each of these switches should be wired into an electrical control panel and the terminals to which they run should be clearly identified. Only one wire should be under a given terminal.

1.5.7 Setup for Hydrostatic Testing

In order to hydrostatically test any device it is necessary that valves are available to isolate the device, a test port is available to apply the test pressure, and a pressure gage is available to monitor the pressure in the device (See Figure 1.4). All devices that could be damaged by the test pressure must be removed prior to conducting the hydrostatic testing.

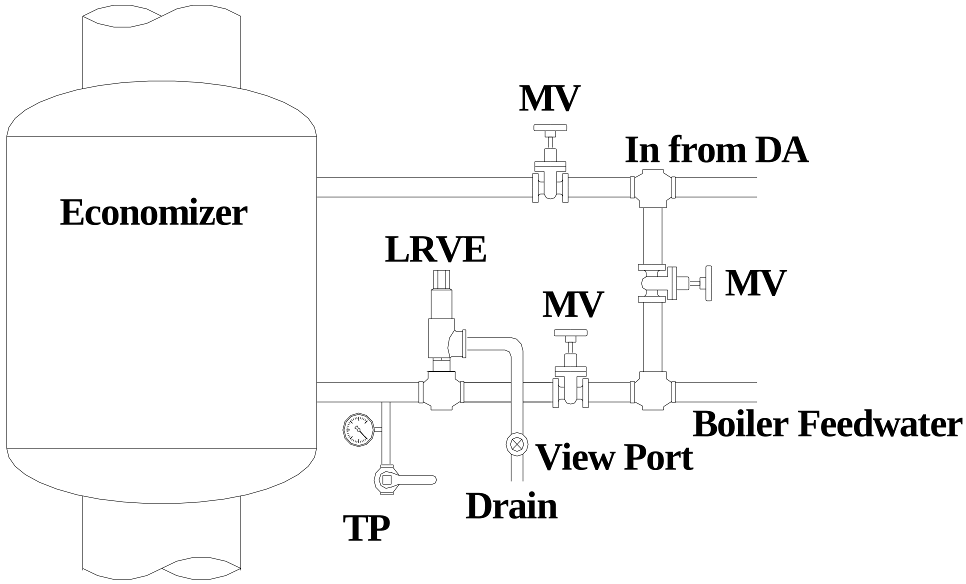


Figure 1.4 Hydro Testing

2 WATER LEVEL CONTROL

2.1 LOW WATER CUTOFFS

2.1.1 Description

A low water cutoff is a device that causes causing the automatic fuel safety shutoff valves to close if the water level in the boiler drops below a pre-set safe level. Low water causes about 50 percent of all boiler incidents. Low water can cause the boiler to overheat which could lead to the failure of the pressure vessel with enormous potential damage (explosion). Two low-water cutoffs are required. Low-water cutoffs operate either on a "float" system or electrode system. In the float system there is a cross arm connection to the boiler (high and low connection points). Between these connection points there is a vertical section containing a volume sufficient to house the float. If the water level falls below a prescribed level, the falling float will cause a switch to actuate causing the automatic fuel valves to close. (See Figure 2.1)

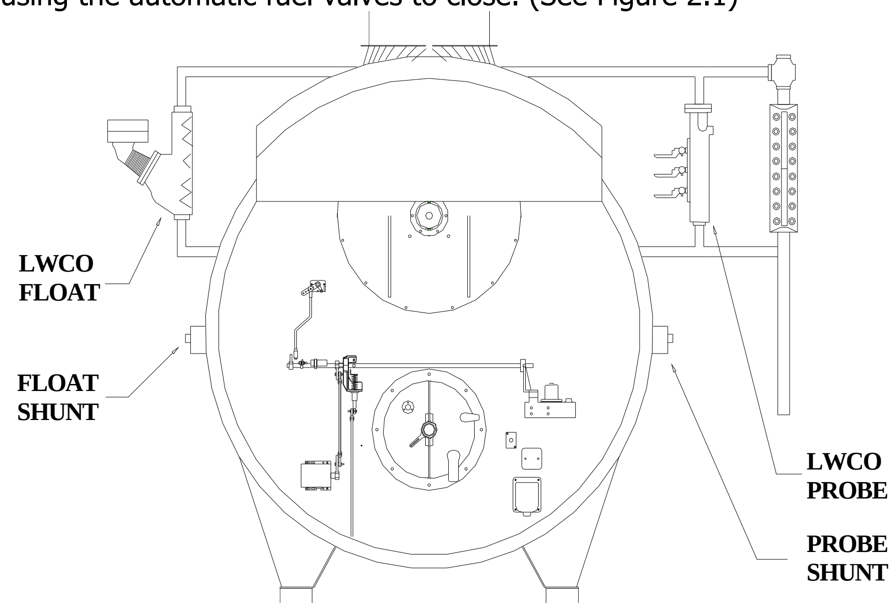


Figure 2.1 Low Water Cutoff

In the electrode system, there is a similar cross arm arrangement as in the float system. Probes extend vertically downward into the vertical pipe connecting the cross arms. The electrodes are located at the bottom of the probe and are used to measure the conductivity of the media in which the electrodes are immersed. The conductivity of water is much higher than steam. Hence, if the water level drops below the probe, a drastic change in conductivity occurs. This change is used in an electrical circuit to cause the automatic fuel shut-off valves to close. Most safety codes require at least one float system be included to protect against low water. This is shown in Figure 2.1. The VA requires one float and one probe. True redundancy requires two separate cross arm arrangements. Use of a single cross arm could lead to a situation in which blockage in the cross arm renders both level control safety devices useless.

Some low-water cutoffs are provided with non-latching "shunt" switches by which the cutoff switch is bypassed. Arrangements for shunt switches include individual shunt switches on one or both cutoffs or a switch which shunts both cutoffs. Operators can use the shunt switch in "testing" of the low-water cutoff to prevent the boiler from shutting off. Operators electrically check the low-water cutoff using this method. When no shunt is available or the shunt is across both low water cutoffs, it is necessary to use an electrical jumper to temporarily by-pass one cutoff in order to test the other cutoff.

A boiler control system should never allow the boiler to automatically restart after a low-water cutoff has actuated to stop boiler operation.

A detailed step by step test procedure is given in Appendix A.

2.1.2 Consequences of Low Water Cutoff Failure
If the low water cutoffs both fail, the boiler would then be fired with no water in the boiler. This will cause the metal temperatures to rise rapidly and the metal strength to be significantly decreased. In fire tube boilers the main Morrison tube typically collapses which could allow steam onto the boiler fireside. The steam pressure has been known to blow the ends out of the boiler through concrete block walls a distance of hundreds of feet. Similar catastrophes could occur in water tube boilers.

2.1.3 Testing a Low Water Cutoff

Low-water cutoffs must be tested in a mode in which they fail. Testing is basically done by allowing the water level to lower in a "slow drain". In order to be in a realistic mode, one must not follow a procedure that actuates the cutoff by <u>rapidly</u> blowing off a volume of water from the cross arms. This is very important in testing a float type cutoff. It is recommended that the rate of decrease in water level be a maximum of 1 inch/minute.

A detailed step by step test procedure is given in Appendix A.

2.2 LOW WATER ALARM

2.2.1 Description
The low water alarm provides audible and visual warnings that the water level is approaching a dangerously low level. These alarms are based either on a conductivity probe or float as described in the previous section. These alarms are used on the boiler, deaerator and condensate receiver tanks. On the boiler, the low water alarm must be set to activate before either of the low water level cutoff switches shuts off the boiler. On the deaerator and condensate receiver tanks, the alarm is the only indication of a low water problem. On these devices the setting should be above the point of pump cavitation and with visible water in the sight glass. The alarm should not be set so high that it causes excessive alarm activation. Of course lack of water in the deaerator or condensate receiver will quickly result in loss of water to the boiler with the problems described in the section of low water level control.

The alarm testing should include a careful consideration as to whether the alarm setpoint is at the correct level for its intended purpose.

2.2.2 Consequence of Water Level Alarm Failure
Low water in a condensate or deaerator tank is a precursor to low water failure in a boiler with the problems described above. There is also the hazard of damage to a

condensate transfer or boiler feed pump from running dry. A low water alarm on a boiler is a warning to operators of an impending potential problem of a "boil out" of water.

2.2.3 Testing Low Water Alarms

This alarm is tested by causing a drop in water level in the vessel being tested. The alarm should activate at the desired setpoint (the setpoint must be above the level at which dangerous operations will occur, at a level allowing operators to restore the proper level, and visible in the appropriate sight glass).

A step by step procedure is given in Appendix A for three situations: boilers, deaerators, and condensate tanks.

2.3 HIGH WATER ALARM

2.3.1 Description

A high water alarm is used on a boiler, deaerator, and condensate tanks to aid in preventing overfilling. Due to the failure rate of float type devices used for this purpose, high water alarms should always be a conductivity probe type device.

2.3.2 Consequence of High Water Alarm Failure

High water in a condensate tank could lead to backup of condensate in condensate lines. High water in a deaerator will result in poor deaeration but also leads to violent shaking of the vessel. High water in a boiler could result in pushing liquid into the steam line. Slugs of water in the steam system can move at high velocity due to the motive force of steam causing water hammer. Water hammer can cause valves and other fittings to explode and steam piping to rupture. Death and injury from these events is a regular occurrence. This same effect could produce high water levels in the steam supply to a steam powered appliance connected to the system with detrimental effects on the process.

2.3.3 Testing the High Water Alarm

The high water alarm can be tested off-line. Slowly fill the vessel with water, observe the water level in the sight glass, and note the point at which the alarm sounds. Be careful not to overfill the system, above the level at which the alarm should actuate.

A step by step procedure is given in Appendix A for three situations: boilers, deaerators, and condensate tanks.

2.4 OVERFLOW DRAIN SYSTEM

2.4.1 Description

Deaerator tanks and condensate storage tanks have overflow systems to prevent overfilling. The deaerator overflow is shown in Figure 2.2. The overflow system on the condensate tank also helps guarantee that the condensate tank remains at atmospheric pressure and consists of a drain line connected to the vessel. The drain line from a deaerator includes a normally closed device that opens if the water level is too high and allows water to drain either to sewer or into the condensate tank. Three different types of overflow control valve systems have been utilized on deaerator tanks:

- A float valve which opens when liquid water comes into a standpipe that has an opening near the top of the deaerator.
- An electronic valve which is operated by a conductivity probe indicating that water level is too high. In this case the water should be drained from the bottom region of the tank to avoid the possibility of exhausting steam in case the valve opens before the water level reaches proper height.
- An electronic valve which is operated by a differential pressure cell indicating that water level is too high. In this case the water should be drained from the bottom region of the tank to avoid the possibility of exhausting steam in case the valve opens before the water level reaches proper height.

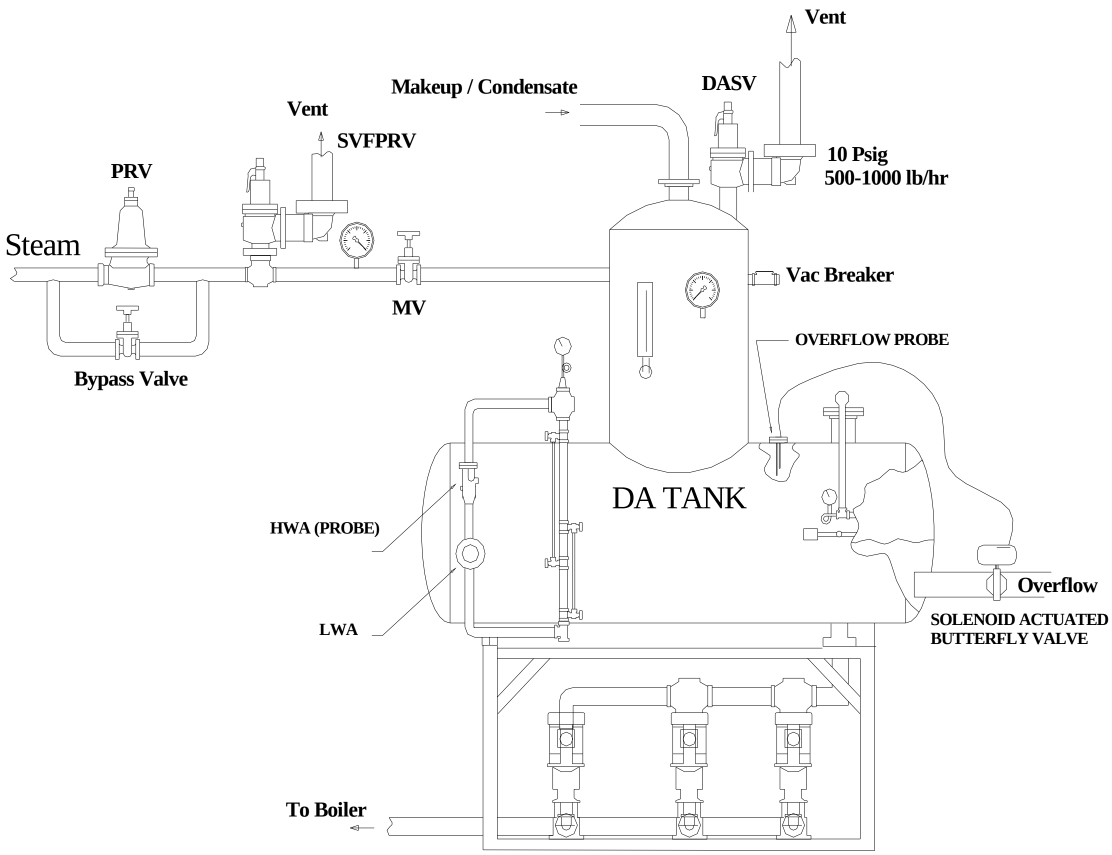


Figure 2.2 Overflow Drain System

2.4.2 Consequence of Overflow Drain Failure

The consequence of an overflow drain failure is the same as that discussed in section 2.3.2.

2.4.3 Testing the Overflow Drain System

The purpose of the test is to determine if the system is capable of draining water from the deaerator at a rate equal to or greater than the maximum potential supply of water to the deaerator. The system can be tested with the deaerator out of service (steam valved out and feedwater pumps off). To test the drain system, fill the deaerator with water at a rate equivalent to the maximum rate that could possibly be supplied to the deaerator. Observe the water level in the sight glass. Use the sight glass to confirm that the drain system is capable of maintaining the water level at the drain level.

A step by step procedure is given in Appendix A.

3 PRESSURE CONTAINMENT

3.1 SAFETY VALVES

3.1.1 Description

The safety valves are connected to a boiler, steam line, or other device that must be protected from over-pressure. Each safety valve discharges into a drip pan ell which discharges through a slip joint into an oversized vent pipe that extends to outside the building. By utilizing drip pan ells, there is no direct connection between the vent pipe and the safety valve so that there is no stress imposed on the safety valve from the thermal expansion of the vent pipe. Liquid relief valves on unheated services, such as fuel oil, can be directly connected to a vent. Safety valves must be present on the boiler, deaerator, any pressurized condensate receiver, and at all points in steam lines just downstream of any pressure-reducing valves. Each safety valve must have a dedicated separate vent line (See Figure 3.1). Properly designed redundant safety systems for this extremely important safety device allow the system to prevent a boiler explosion even if one of the safety valves and / or vent system fails.

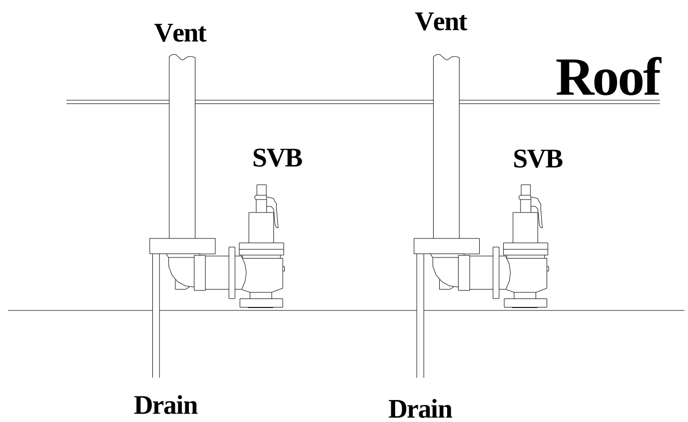


Figure 3.1 Boiler Safety Valves

3.1.2 Consequences of a Safety Valve Failure

Safety valves are the last line of defense against the over-pressurization of the boiler or steam system components. If these valves fail along with all the other measures designed to prevent over-pressurization, a violent explosion could occur. Of course, such an explosion could wipe out buildings and people within several hundred feet of the boiler or system component.

3.1.3 Checking a Safety Valve

The aspects of the safety valve that must be checked include:

- Is the safety valve vented to the outside with proper piping?
- Is the lift pressure set correctly?
- Does the valve open at the correct pressure?
- Are the safety valves present capable of handling the maximum boiler/steam capacity?
- Is the blowdown (set-point minus reseat pressure) correct?

- Is the safety valve properly drained?
- Can the safety valve be safely checked?

Some authorities recommend doing all safety valve testing on a test stand. However, there is a chance that the valves could be mixed up or damaged in installation so that this test method is not as reliable as testing the valves in situ. Also some authorities check a safety valve by lifting the handle. This test does not confirm that the valve opens at its setting. It does confirm that the valve can vent steam (is not blocked). This test should never be performed at a working pressure less than 75 percent of the safety valve setting.

A detailed test procedure which allows the 7 points enumerated above to be checked is given in Appendix A for three situations: boilers, deaerators, and piping following a PRV station.

3.2 RELIEF VALVES

3.2.1 Description

Relief valves are spring-loaded valves that open if the liquid pressure in the system that they protect increases above a pre-set limit. They are similar to safety valves with the exception that they do not exhibit "popping" action or blowdown. (Relief valves do not incorporate the "huddling" chamber found on safety valves). These valves are connected to an exhaust pipe that conveys the fluid to the building exterior or storage tank. Two important pieces of equipment requiring relief valves in boiler applications are economizers and oil pump sets

3.2.2 Consequences of a Relief Valve Failure

Failure of a relief valve could lead to a pressure vessel explosion with serious consequences. For example, there are several cases yearly in which the relief valve on domestic water heaters fail with the result that an entire house is "leveled". A even more devastating event could result from the explosion of an economizer. Failure could also lead to equipment damage due to overheating-e.g. in operation of an oil pump.

3.2.3 Checking a relief valve

There are several aspects of a safety or relief valve that must be checked. These include:

- Is the valve vented with proper piping?
- Is the lift pressure correct?
- Does the valve open at correct pressure?
- Will the valve handle the maximum capacity of the device that it protects?

Testing procedure for the relief valve on an oil pump set and economizers are given in Appendix A.

3.3 HIGH STEAM PRESSURE LIMIT SWITCHES

3.3.1 Description

A boiler should be fitted with two, high-steam-pressure-limit switches (HSPLS). Both switches have the function of causing the two automatic fuel shut off valves to close if a preset pressure limit is exceeded. One switch may be a recycle switch meaning that once the pressure falls below the set point pressure the boiler will automatically restart. The other switch must be a non-recycle switch meaning that it must be manually reset after a pressure excursion above its limit. The pressure setting on the non recycle switch should be slightly higher than the setting on the recycle switch but lower than the maximum working pressure for the boiler. The non-recycle limit should also be lower than the lowest lift pressure for the safety valves. The required differences in the settings described above should be sufficient to allow the boiler to operate without excessive nuisance trips or blowing of safety valves.

3.3.2 Consequences of High Steam Pressure Limit Switch Failure

If both HSPLS switches were to fail, the safety valve becomes the last line of defense against a pressure vessel explosion. A tendency of boiler operators is to not worry about the performance of the HSPLS (especially the non-recycle one) because the safety valve is still available to save the operation. This thinking represents the "slippery slope" in safety because true safety relies on redundant measures. In looking at accidents in industry one can almost always find several unsafe factors that led to the particular accident. Ignoring the first warning escalates the risk.

3.3.3 Checking High Steam Pressure Limit Switches

Items to be checked about the HSPLS include:

- Are the limits on the switches set correctly, and
- Do the switches work?

These tests are described in Appendix A.

3.4 BOILER HYDROSTATIC TESTING

3.4.1 Description

A hydrostatic test is performed on a boiler, deaerator, and economizer to determine if it is capable of withstanding the potential operating pressure. It is very important to understand that any leak is a sign of weakness in the vessel and should be thoroughly inspected by a professional and properly repaired before the vessel is put back into operation. (These leaks could represent small cracks or metal thinning/corrosion/etc that is not discernable to the eye).

3.4.2 Consequences of Failure to Hydrostatic Test

If weak spots are present and the vessel is operated, a significant chance exists that a pressure vessel explosion could occur with tremendous loss of property and life. Failure to perform a proper hydrostatic test would allow a weakened vessel to be operated with the attendant dangers of such operation.

3.4.3 Performing a Hydrostatic Test

To perform a hydrostatic test, fill the vessel completely full of water below 200 F. Remove and plug all safety and relief valves. Close all supply and discharge lines. The boiler should be completely locked and tagged out from all energy sources following OSHA requirements and the fireside opened for inspection. The hydrostatic pressure for the test at about 1.5 times working pressure should be applied for several hours. The dry side should be checked for any sign of leaks. Any leaks should be professionally evaluated in terms of whether the vessel can be operated safely without repair.

In applying the hydrostatic pressure, care must be exercised not to overpressure the vessel. If the vessel were pressurized above its elastic limit, the vessel would not be fit for further use and should be scrapped!

4 FUEL TRAIN SAFETY DEVICES

4.1 LOW PRESSURE FUEL CUTOFF SWITCH

4.1.1 Description

The low-pressure fuel cutoff switch causes the automatic fuel shutoff valves to close if the fuel pressure is below the lower limit for safe operation. LPFCS safety devices are found on the main gas line, main oil line, and pilot gas line. The switch in all three of these applications senses the supply fuel pressure after the pressure regulating valve and upstream of any fuel control valve (See Figure 4.1). For the main oil and gas supply lines, the switch is in continuous operation once the boiler is in the run mode. For the pilot gas supply, the switch operates continuously while the pilot flame is on.

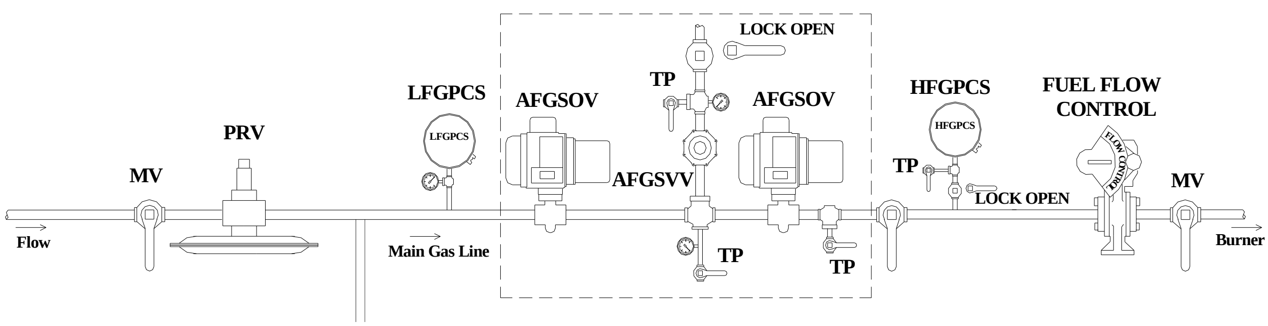


Figure 4.1 Low Pressure Fuel Cutoff

4.1.2 Consequences of Low Pressure Fuel Cutoff Switch Failure

Low fuel pressure can result in unstable burning or flameout conditions. When fuel pressure returns to normal, the combustion chamber can overfill with fuel before igniting. This can easily result in combustion explosions that are violent enough to blow the "ends" of the boiler and even through surrounding structures. Extensive property damage, injury, and even death can result.

4.1.3 Checking the Low Pressure Fuel Cutoff Switch

The checking procedure for this switch is designed to answer three questions:

(1) Is the switch in correct place?
(2) Are its limits correctly set?
(3) Does the switch work to produce the desired result?

The switch should never be located upstream of the pressure regulating valve and should never be located downstream of the fuel flow control valve. The low pressure limit should be 80% of the normal regulated supply pressure. (On gas operation, some pressure regulation devices require improvement because they allow a substantial "dip" in supply pressure on initial light-off). A step by step test procedure for the low pressure fuel cut out switch for the main gas and main oil supply systems as well as the pilot gas system is given in Appendix A.

4.2 HIGH PRESSURE FUEL CUTOFF SWITCH

4.2.1 Description

The high fuel pressure cutoff switch is used to cause the automatic fuel shutoff valves to close if fuel pressure is above a given the higher limit for safe operation. These switches are used for both the main gas and main oil fuel supply systems (See Figure 4.2). In both of these applications the switch senses the supply fuel pressure after the pressure regulating valve and upstream of the fuel control valve. The switch is in continuous operation once the boiler is in the run mode.

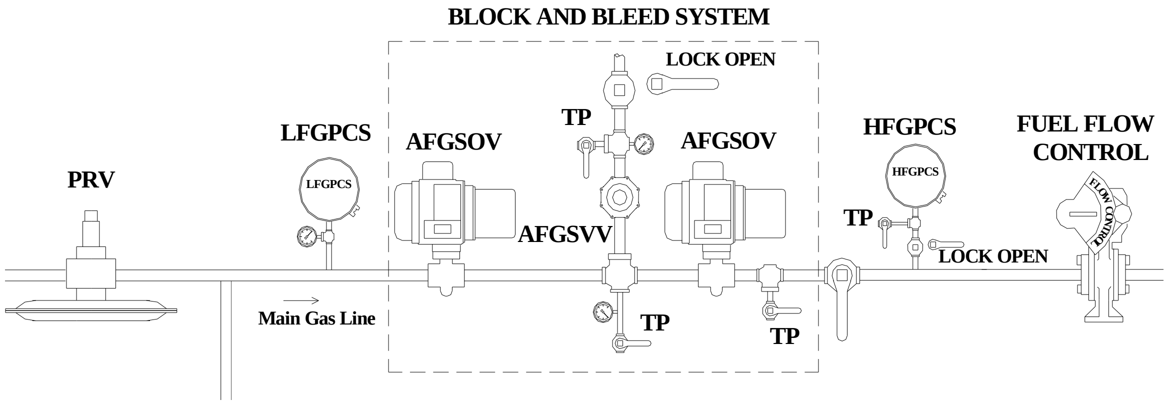


Figure 4.2 High Pressure Fuel Cutoff

4.2.2 Consequences of High Pressure Fuel Cutoff Switch Failure

High fuel pressure can cause unstable flame conditions but more importantly it can result in over-firing the boiler. Over-firing can damage burner/boiler materials to the point of meltdown and explosion. The generation of steam can be so intense that a pressure vessel explosion can occur. High fuel pressure can easily occur if a pressure regulator and high-pressure cutoff switch were to fail.

4.2.3 Checking the High Pressure Fuel Cutoff Switch

The checking procedure for this switch is designed to answer three questions:

- Is the switch in correct place?
- Are its limits correctly set?
- Does the switch work?

The switch should never be located upstream of the pressure regulating valve and should never be located downstream of the fuel flow control valve. The high pressure limit should be 120% of the normal regulated supply pressure for natural gas and 110% for light oil.

A step by step test procedure for the high pressure fuel cut out switch for the main gas and main oil supply systems is given in Appendix A.

4.3 VENTING BETWEEN AUTOMATIC GAS SHUTOFF VALVES

4.3.1 Description

The volume between the automatic fuel shutoff valves for gas should be vented to the atmosphere with a system as shown in Figure 4.3 for both the main gas and pilot line automatic shut off valves. While the boiler is running the solenoid valve is shut and gas flows through the two automatic shutoff valves to the burner. When the fuel shut-off valves close, the solenoid valve opens and vents any residual gas in the space between the valve and any leakage of gas through the first automatic shutoff valve.

The purpose of the vent system is to insure that even if the first automatic shutoff valve leaks, the gas is vented rather than allowed to move through the second automatic fuel-shutoff valve and then into boiler. The vent line should be vented to the atmosphere.

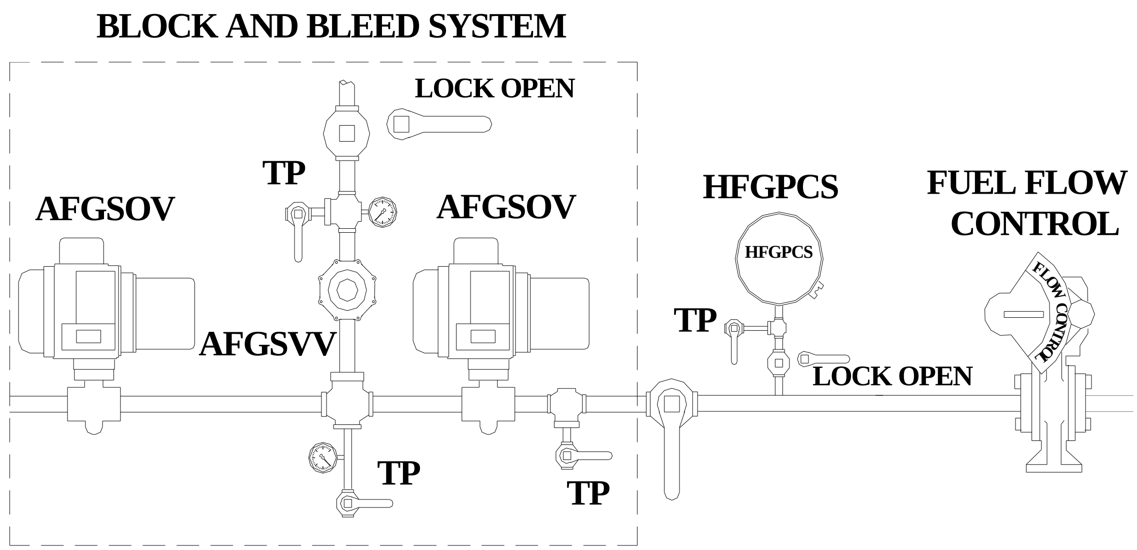


Figure 4.3 Gas Train Vent Valve

4.3.2 Consequences of a Failed Vent Valve

Fuel leaks into the boiler are obviously dangerous because if both automatic shut off valves leak, gas would fill the boiler furnace while the boiler is off. Fuel mixed with air is an explosive. Any source of ignition could result in disaster. On ignition if purging did not adequately vent this gas, a tremendous explosion would result when igniting the fuel. This combustion explosion could easily wipe out all property and personnel within several hundred feet of the boiler.

4.3.3 Testing the Gas Train Vent Valve (solenoid valve)

Testing of the vent system should include verifying that the correct physical system is in place, that the vent valve is closed (does not leak) when the boiler is firing, and that the vent valve is open when the boiler is not firing. Vent piping should be checked for insect nests that can block the flow of gas.

A detailed step by step procedure to check all these aspects of the vent valve are given in Appendix A.

4.4 LEAK TEST OF AUTOMATIC FUEL SHUT OFF VALVES

4.4.1 Description

A block and bleed system is provided as discussed in section 4.3 to prevent fuel from entering and potentially collecting in the boiler while the boiler is off. This system is used on the main oil and gas supply lines to the burner as well as the pilot gas supply. (On the main oil supply line a vent is not required.) The two automatic shut off valves used in either case are the means by which the boiler is automatically shut down in case any operating limit is not satisfied. It is absolutely essential that these valves do not leak when closed. For both oil and gas, applicable codes require two automatic shut off valves. It is that important.

4.4.2 Consequences of Leaking Automatic Shut off Valves

There is a slight probability that one or more of the automatic fuel shut off valves would leak. If both valves leaked and the vent system did not function in the case of gas, fuel would be introduced into the burner and into the boiler furnace while the boiler is off. This fuel would produce a combustible mixture in the boiler. Fuel leaks into the boiler are obviously dangerous because it allows the presence of a combustible air-fuel mixture that could explode when the fuel is ignited on startup. This combustion explosion could easily wipe out all property and personnel within several hundred feet of the boiler.

4.4.3 Testing the Automatic Fuel Shut off Valves for Leaks

The testing for leaks can be done when the boiler is off. The best test procedure for gas is a situation in which the leak could be measured with a "bubble test". This method involves connecting a tube to a confined space downstream of the valve being tested with positive pressure on the upstream side of the valve. The tube is placed approximately 1/16th of an inch below a water surface. Any leak will show up as a bubble generated in the water at the tube exit. Any testing by watching pressure fall is difficult to evaluate because generally there are many potential sources for leaks in the system which will obscure the results. For oil a test port can be provided to visually observe whether oil drains from the test port.

A step by step procedure is given in Appendix A.

4.5 OIL LOW ATOMIZING MEDIA PRESSURE SWITCH

4.5.1 Description

An atomizing fluid (compressed air or steam) is usually used to aid in the combustion of the oil fuel (See Figure 4.4). A safety switch is required that shuts the boiler off in case of low atomizing pressure. This switch measures pressure in the atomizing fluid line immediately after the pressure regulating system and causes the automatic fuel control valves to close if the atomizing pressure falls below its setpoint. If there is a differential pressure regulator, the sensor should be located upstream of that regulator.

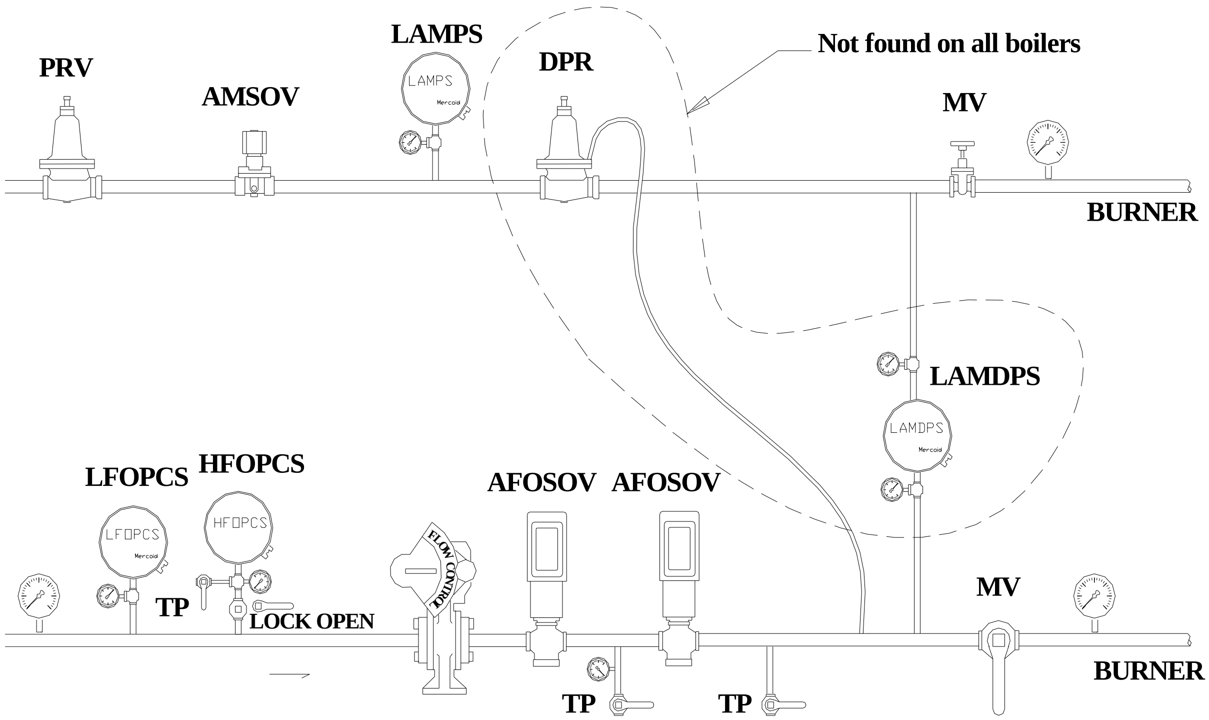


Figure 4.4 Low Atomizing Media Pressure Switch

4.5.2 Consequences of Low Atomizing Media Pressure

Low atomizing pressure could cause poor combustion leading to the production of carbon monoxide, flame instability, and possible combustion explosions leading to serious loss of property and injury/death.

4.5.3 Testing the Oil Low Atomizing Media Pressure Switch

There are basically three items that need checking;

- Is the switch correctly set?
- Is the switch located correctly?
- Does the switch work to produce the desired effect?

The setpoint on the oil low atomizing pressure switch should not allow the atomizing media pressure fall below level recommended by the burner manufacturer. Testing is accomplished on-line by slowly lowering the oil atomizing media pressure and observing that the switch operates at the correct set point. In order to test the low oil atomizing media switch a calibrated pressure gage or other method to measure pressure is required. Make certain that the burner is producing negligible combustibles at the set point pressure condition.

A step by step procedure is given in Appendix A.

4.6 AUTOMATIC FUEL SHUTOFF VALVE PROOF OF CLOSURE SWITCH

4.6.1 Description

The function of an automatic fuel shutoff valve is absolutely essential. All safety devices that require fuel shutdown rely on the two automatic fuel shutoff valves to perform this task. Proof of Closure switches must be present in both automatic shut off valves. Both oil and gas automatic shut off valves require proof of closure switches. The switches in the two valves should be wired in series so that an indicated failure in either valve will prevent the boiler from starting. The proof of closure switch is an integral part of the automatic fuel shutoff valve. It has a simple function to guarantee that the automatic fuel shutoff valve is closed before allowing the boiler to go through the burner startup sequence. If the automatic fuel shutoff valve is not closed, the proof of closure switch will be open, breaking the circuit and not allowing the burner to start. The proof of closure switch is active only during the startup sequence.

4.6.2 Consequences of a Failed Proof of Closure Switch

If the proof of closure switches fail, they could "stick" closed even with the valve open. This malfunction would present a false signal to the burner management system indicating that the valve is closed when it might not be closed. This malfunction could allow the fuel to be ignited with a large quantity of fuel in the furnace. Under this scenario, a horrible combustion explosion would occur. The result could be a tremendous loss of property and death as well as physical harm to personnel within several hundred feet of the boiler.

4.6.3 Testing the Automatic Fuel Shutoff Valve (Proof of Closure) Switch

In order to test a proof of closure switch one must demonstrate the following:

- That the switch is closed when the valve is closed.
- That the switch opens immediately once the valve starts to open.
- The boiler will not start with the switch open.

A detailed step by step procedure to determine whether the proof of closure switches meet the above requirements is given in Appendix A.

5 BURNER AND AIR TRAIN SAFETY DEVICES

5.1 THE FLAME SCANNER

5.1.1 Description

A flame scanner is a device that continually monitors the flame to determine whether a flame is present in the combustion chamber. If the flame is extinguished for any reason, the scanner causes the two automatic fuel shutoff valves to close.

Modern flame scanners work by converting either the ultraviolet (UV) or infrared (IR) portion of the thermal radiation produced by the flame to an electrical signal. The UV scanner has some disadvantage in that it can sometimes see the igniter spark as a flame. The IR scanner has a disadvantage in that it can mistake glowing refractory for a flame. Properly adjusted, the UV scanner is superior and is required by the VA. The strength of the electrical scanner signal is then the indication as to whether an adequate flame is present.

UV scanners can fail unsafe, showing a flame detected when none is present. Some organizations do not consider this a problem on boilers that cycle on/off frequently as the burner management system will not allow a burner to start if a flame is "detected" while the burner is off. On V.A. boilers, which operate continuously for long periods, it is necessary to utilize "self-checking" UV scanners. The "self-checking" feature detects a scanner failure and immediately shuts down the burner."

5.1.2 Consequences of a Failed Flame Scanner

If the flame scanner allows fuel to be supplied to the combustion zone when no flame exists, horrific combustion explosions can occur. The combination of a spark due to some type of "glowing" material and a "pocket" of fuel/air mixture at an explosive ratio can result in an explosion. Another scenario is relighting the boiler with an explosive mixture of fuel and air present. There have been numerous accidents in which the front or back of the boiler have blown off and through masonry walls with loss of life and property damage.

5.1.3 Checking a Flame Scanner

There are many potential tests for a flame scanner depending on the situation. The guiding principle is to try to check the scanner operating in the same mode that a potential failure might occur. The best test is then to cause the flame to extinguish and to determine whether the flame scanner then causes the two automatic fuel shut-off valves to close. It is very important that the flame scanner be checked on both oil and gas firing.

There are really three attributes of the flame scanner that one should check:

1. Is the flame scanner a UV self-checking scanner?
2. Does the flame scanner sense the igniter spark?
3. Will the flame scanner cause the automatic fuel shut-off valves to close within the allowable time (4 sec) when the fire is extinguished?

A detailed step by step procedure is given for testing the flame scanner in Appendix A.

5.2 LOW FIRE PROVING SWITCH

5.2.1 Description
In the startup procedure for the boiler, the safest way to light the main burner is with a minimum of fuel input. There are electrical position switches located on the control systems for the fuel flow control valves and the combustion air damper that activate when the damper is at low-fire position. These low-fire proving switches have the function of not allowing the main flame to be ignited if the firing position is not a minimum. In some electronic control systems a potentiometer is used to determine the position of the inlet damper by the output of a voltage level to the controller. The required V.A. system is position switches actuated by the fuel control valves and the damper themselves rather than at some point nearer the drive motors that operate the valves and damper. Parallel position systems require separate proof of the low fire position for air and fuel.

5.2.2 Consequences of a Failed Low Fire Proving Switch
Failure of the low-fire proving switch could allow the boiler to start in a high fire position. This result could easily lead to a violent combustion explosion with property loss as well as injury and death to individuals within a few hundred feet of the boiler.

5.2.3 Testing the Low-Fire Proving Switch
The low-fire proving switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch "activated" at any position other than "low fire"?
- Does the switch in the non-activated position prevent the boiler from firing?

A detailed step by step procedure for testing the low fire proving switch is given in Appendix A.

5.3 COMBUSTION AIR FLOW SWITCH

5.3.1 Description
A combustion airflow switch is used for the purpose of causing the two automatic fuel shutoff valves to close if the forced draft fan is not producing airflow (See Figure 5.1). Typically, this switch uses a pressure measurement across the fan. The switch is in the safety control circuit anytime the boiler is in the run position. A set point for the switch is established by measuring the minimum pressure rise seen by the switch over the firing range and setting its value at approximately 80% of the minimum pressure rise. For the combustion air flow switch one desires that the pressure rise being measured is as large as possible and is "flat" i.e. independent of firing rate.

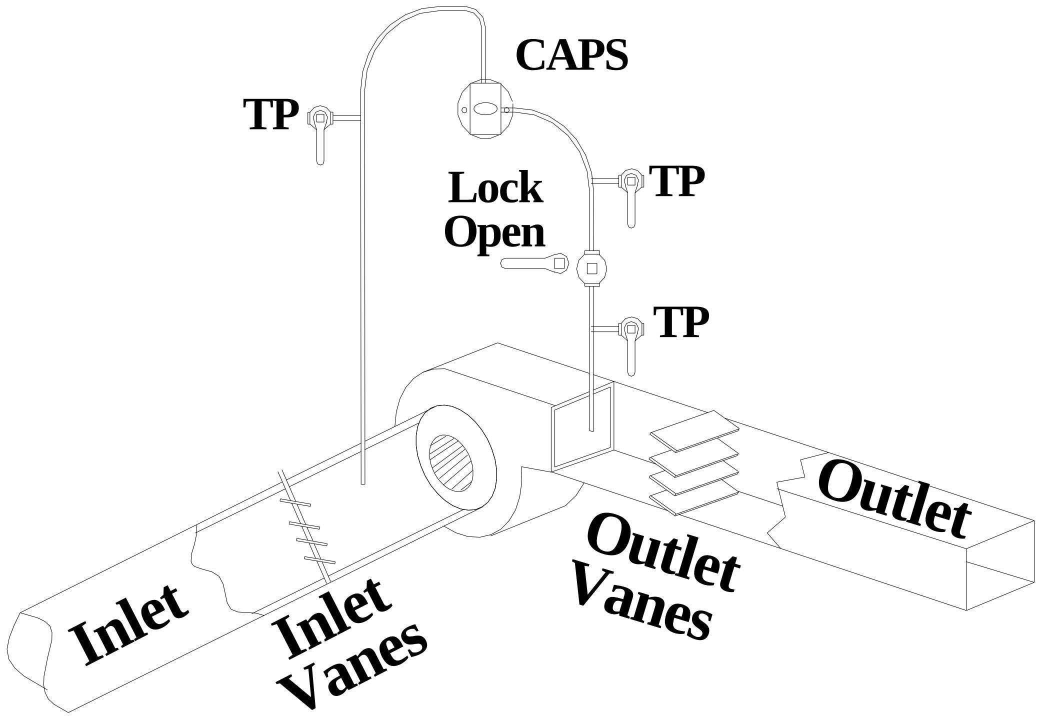


Figure 5.1 Combustion Air Pressure Switch

5.3.2 Consequences of a Failed Combustion Air Switch

If the fan fails to produce adequate combustion air, seriously incomplete combustion will occur. The flame will be highly unstable and the risk of a combustion explosion which could send boiler parts flying for several hundred feet is high. In addition, the production of carbon monoxide with its attendant toxicity can easily cause death for operators.

5.3.3 Testing Combustion Air Flow Switch

The combustion air flow switch should be tested while the boiler is running. There are basically three things that should be tested:

- Is the switch located correctly?
- Is the switch setpoint correct?
- Does the switch stop the boiler from firing with insufficient combustion air?

A detailed step by step procedure for testing the combustion air flow switch is given in Appendix A.

5.4 PURGE AIR FLOW PROVING SWITCH

5.4.1 Description

The purpose of the purge airflow-proving switch (PAPS) is to insure that during purging sufficient air volume is moved through the boiler. Four air changes are required for fire tube boilers and 8 air changes are required for water tube boilers. A boiler cannot be overpurged. Hence, the PAPS serves the role of proving airflow rate during purging. The PAPS works by measuring pressure change across a boiler element. One desires that the switch sees a small pressure change at low fire with a much larger change in the purge (high fire) position. Typically this pressure should be measured across the boiler bank without variable restrictions. The proper set point for the switch is approximately 80% of the maximum pressure change sensed by the switch.

5.4.2 Consequences of a Failed Purge Airflow Proving Switch

If this switch were to malfunction, it would be possible to ignite the pilot and or main flame with combustible gas mixtures present in the boiler. This could lead to a terrible combustion explosion with serious loss of property and life.

5.4.3 Testing the Purge Airflow Proving Switch

The purge air flow proving switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch located correctly (i.e. pressure taps across right element)?
- Is the switch setpoint correct?
- Does the switch in the non-activated position stop the boiler from leaving purge?

A detailed step by step procedure for testing the purge air flow proving switch is given in Appendix A.

5.5 BURNER POSITION SWITCH

5.5.1 Description

Some manufacturers of oil burners require a position switch to indicate that the burner is in the correct position before firing. The switch is generally a simple proximity switch that is electrically closed by depression of the switch by the burner as it is fully inserted into the boiler. For those boilers utilizing this switch it must be tested.

5.5.2 Consequences of Burner Position Switch Failure

If the boiler could fire on oil with the burner partly retracted, fire, production of carbon monoxide, flame instability, and combustion explosions could result. This could lead to serious loss of property and injury/death.

5.5.3 Testing the Burner Position Switch

The switch must be periodically tested to determine if the boiler would fire on oil with the burner partially retracted. If the switch is properly set up, the boiler control will not allow the boiler to leave purge with the burner out of position. A detailed step by step testing procedure is give Appendix A.

5.6 FORCED DRAFT MOTOR INTERLOCK

5.6.1 Description

The forced draft motor interlock provides an extra level of safety relative to proving "purge air flow" and "combustion air flow" and protects the fan motor from running with an inadequate power supply. There are three types of interlocks currently being used. The simplest interlock is an auxiliary contact which is a single pole switch that "makes" when the main switch supplying 3-phase power to the fan is closed. One could cut any or all of the power leads going to the motor and this switch would indicate acceptable operation. Clearly, this interlock is not acceptable. A second design utilizes phase monitors on all three legs which looks at the incoming power characteristics which will work if one loses incoming power to the panel. However, the fan motor could be disconnected electrically and the phase monitor would indicate acceptable operation. Again this interlock is not acceptable. The proper interlock is based on current relays in which current in all three legs supplying power to the motor is measured (See Figure 5.2). This interlock involves encircling each power lead with a current pickup. The lack of current through any of these current pickups will stop boiler operation. For testing it is best if one uses a type of current pickup around each lead that could be opened and removed without disconnecting the power lead from its terminal strip.

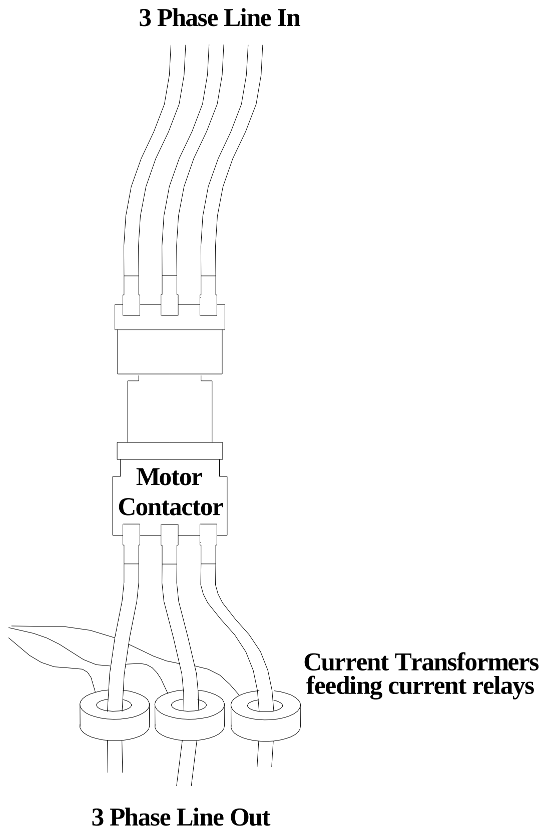


Figure 5.2 Forced Draft Motor Interlock

5.6.2 Consequences of a Failed Forced Draft Fan Motor Interlock

If the fan fails to run or runs at a lower speed, the boiler would produce combustibles leading to the same problems discussed in section 5.5.2.

5.6.3 Testing the Forced Draft Fan Motor Interlock

The test for this interlock consists of determining whether the right type of switch is in place and then removing the current pickups, one at a time, and determining if the boiler shuts down. A detailed step by step procedure is given in Appendix A.

5.7 FURNACE PRESSURE INTERLOCK

5.7.1 Description

The purpose of the high furnace pressure interlock (FPI) is to insure that the furnace pressure does not exceed an acceptable limit due to some type of blockage. The FPI works by measuring pressure in the boiler furnace while the boiler is running. A pressure that exceeds the FPI setpoint "breaks" the interlock to an open position and causes the boiler to shut down. The proper set point for the switch is approximately 120% of the actual furnace pressure at high fire condition.

5.7.2 Consequences of Low Furnace Pressure Interlock Failure

A blockage in the exit portion of the boiler combustion gas circuit, leads to high furnace pressure and incomplete combustion. Under this condition carbon monoxide is generated and the combustion gases are potentially highly explosive. If the FPI were to malfunction two highly undesirable consequences might occur. First, high furnace pressure would cause incompletely combusted gasses internal to the boiler furnace to be expelled into the boiler room. Carbon monoxide levels in the boiler room could reach a point where occupants would be killed. Secondly, these incomplete combustion gases could explode if a supply of oxygen became available (For example the flame might be temporary extinguished, and the explosively re-ignited by a "hot spot" in the boiler.) Therefore, the consequences of a failed FPI could be the loss of life of many people from carbon monoxide poison and flying debris from a boiler explosion.

5.7.3 Testing the Furnace Pressure Interlock

The FPI can be tested by first determining the furnace pressure at high fire in order to establish a proper setpoint for the interlock. It can then be tested offline by pressurizing the interlock with air. There are basically four items that need checking;

- Is the switch located correctly (i.e. pressure taps between the internal volume of the boiler furnace and atmosphere)?
- Is the interlock set point correct?
- Does the interlock break at the correct set point?
- Does the interlock in the open position stop the boiler from operating?

A detailed step by step procedure for testing the FPI is given in Appendix A.

5.8 OUTLET DAMPER POSITION INTERLOCK

5.8.1 Description

The purpose to the outlet damper position interlock (ODPI) is to insure that the outlet damper is open during purge. This interlock is a part of the safety system to insure that adequate purging has occurred prior to the ignition sequence. Therefore, it is a pre-ignition interlock. The ODPI is a displacement electrical switch that should be activated by movement of the outlet damper into the correct position for purging. (In many cases this interlock is on the jackshaft drive motor that is linked to the damper, but this arrangement does not meet VA specifications.) If the interlock is not "made", the safety controller for the boiler does not allow the boiler to leave purge.

5.8.2 Consequences of Outlet Damper Position Interlock

A blockage in the exit portion of the boiler combustion gas circuit due to a closed or partially closed outlet damper, leads to inadequate flow of combustion air. Under this condition there is the potential for highly combustible gases to be present in the boiler furnace after purging is complete because the air flow restriction reduces the volume of purge gases to the point hat combustible gases remain in the boiler or exhaust system. If the ODPI were to fail, these incomplete combustion gases could explode when the igniter attempts to light the pilot. This explosion would cause boiler parts to fly hundreds of feet leaving anyone in its path badly injured or dead.

5.8.3 Testing the Outlet Damper Position Interlock

The ODPI can be tested by determining the point at which the interlock "makes". This point should be with the outlet damper within one or two degrees of wide open. A wire can then be disconnected from the interlock which would simulate a failed interlock. The boiler should not prove purge under this condition. There are basically three things that should be tested;

- Is the interlock located correctly (i.e. actuated by damper movement itself)?
- Does the interlock "make" at the proper point?
- Does the interlock prevent boiler from leaving purge if it is not "made"?

A detailed step by step procedure for testing the ODPI is given in Appendix A.

5.9 FORCED DRAFT DAMPER WIDE OPEN PRE-PURGE PROVING SWITCH

5.9.1 Description

The FDDWOPS is necessary to show that the inlet vanes are wide open for purge. This switch is of the proximity type. It can be located such that the movement of the linkages moving the inlet vanes activates the switch when the vanes are in the wide-open position. The VA required system would be a switch actuated by the damper itself rather than at some point nearer the drive motor operating the damper.

5.9.2 Consequences of a Failed FDDWOPS

If this switch failed, the boiler and stack could contain a highly explosive mixture of combustible gases due to inadequate purge. This gas mixture could explode when either the pilot or main flame are operated. This massive explosion would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.9.3 Testing the FDDWOPS

The FDDWOPS should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch "activated" at any position other than "high fire"?
- Does the switch in the non-activated position prevent the boiler from firing?

A detailed step by step procedure for testing the FDDWOPS is given in Appendix A.

5.10 PRE-PURGE AND POST-PURGE TIMERS

5.10.1 Description

There is a purge cycle at light off and also when the boiler shuts down. The purpose of purging is to make sure that no combustible gas is present in an unfired boiler nor prior to pilot ignition. It is necessary to prove that the purge cycle extends for the correct duration to achieve the required air changes, as determined by the applicable codes. A timer in the burner management system accomplishes this function. Older timers, no longer acceptable, can be adjusted at any time. Timers that are acceptable are adjusted when the burner is commissioned and then "burn in" the timing so that subsequent changes cannot be made without replacing the timer. Codes require that fire tube boilers have a minimum pre-purge of 4 air changes and water tube boilers a minimum of 8 air changes. Before testing, one must verify the correct duration of the purge cycle. Generally, post purge timing is 15 seconds, minimum.

5.10.2 Consequences of Improper Purge Timing

If the timer does not function correctly, the boiler and stack could contain a highly explosive mixture of combustible gases due to inadequate purge. This gas mixture could explode when either the pilot or main flame are operated. The massive explosion that results would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.10.3 Testing the Pre and Post Purge Timer

The test is simple in that the duration of purge can be measured simply with a stop watch. The amount of purge air actually moved is more difficult to determine. An approximate calculation for the cubic feet of air moved is given by the following formula:

Standard Cubic Feet of Air =

[(boiler steam capacity in lb/hr)/3600] x [purge duration in seconds]/.075

This amount of cubic feet of air should exceed four times the fireside volume of a firetube boiler and eight times the fireside volume of a water tube boiler. A detailed step by step test procedure is given in Appendix A.

5.11 IGNITER TIMER AND MAIN FLAME IGNITION TIMER

5.11.1 Description

The igniter serves as a spark to light the pilot flame. Moving quickly from an ignition source to pilot light to main flame does not allow a large amount of combustible gas in the boiler without the presence of an ignition source at anytime during light off. The igniter and main flame ignition time is controlled by the burner management system and should not be adjustable by operators. NFPA currently sets the maximum igniter spark duration of 10 seconds. For natural gas or light oil, the time allowed from the time that the two automatic shut off valves open until they close is 14 seconds (this is 10 sec for main flame ignition and 4 seconds for valves to close).

5.11.2 Consequences of Excessive Igniter or Main Flame Ignition Timing

If the igniter stays on too long and the pilot flame fails to ignite, an excessive amount of pilot gas could enter the boiler leading to a boiler explosion. Similarly if the trial time for main flame ignition is excessive, large amounts of fuel could enter the boiler and subsequently explode. Such explosions would likely cause severe property damage and personal injury and death in an area several hundred feet from the boiler.

There is an electronic timing mechanism that regulates the duration of time that the igniter produces a spark. If the trial for ignition (igniter or main flame) is too long, it allows time for a large amount of combustible fuel to enter the boiler. Then if ignition does finally occur the massive explosion described above will take place

5.11.3 Testing the igniter timer

The test of igniter time requires that one close both the main and pilot fuel supplies and measure the time the igniter is on during start up of the boiler. To test the time for trial for main flame, pilot gas is supplied to the boiler with the main fuel line manual valve closed. With this set up a stop watch can be used to measure the time that the main fuel valves remain open during an attempt to start the boiler. A detailed step by step procedure for these tests is given in Appendix A.

5.12 AUTOMATIC FUEL SHUTOFF VALVE CLOSURE TIME AFTER MAIN FLAME FAILURE

5.12.1 Description

When the main flame is extinguished for any reason, the flame scanner should sense a lack of flame and, through the burner management control system, cause the automatic fuel shutoff valves to close. It is essential that these valves close quickly to prevent large amounts of combustible fuel from entering the furnace without a flame present. It should take less than 4 seconds for the automatic fuel valves to close and in most case about 3 seconds.

5.12.2 Consequences of Excessive Time to Close Main Fuel Valves

If large amounts of combustible fuel were present without a flame due to the automatic shut off valves remaining open too long after a flame failure, and subsequently ignition sources were applied, a massive boiler explosion would result likely causing severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.12.3 Testing the Automatic Fuel Shutoff Valves Closure Time After a Main Flame Failure

The automatic fuel shutoff valve closure time can be tested at the same time the flame scanner is tested. The test is conducted with the boiler running. The fuel supply to the boiler is cut off by the manual valve located just before the burner and the time for the automatic fuel shut off valves to close is measured. A detailed step by step test procedure is given in Appendix A.

5.13 AUTOMATIC FUEL SHUTOFF VALVE CLOSURE TIME AFTER IGNITION FLAME FAILURE

5.13.1 Description

If the pilot flame fails during the ignition period, the flame scanner should sense a lack of flame and, through the burner management control system, cause the automatic fuel shutoff valves to close. It is essential that these valves close quickly to prevent large amounts of combustible fuel from entering the furnace without a flame present. If large amounts of combustible fuel were present without a flame and subsequently ignition sources were applied, a massive boiler explosion would result likely causing severe property damage and personal injury and death in an area several hundred feet from the boiler.

5.14 MINIMUM PILOT FLAME TEST

5.14.1 Description

The startup sequence begins with an electronic spark that is used to ignite the gas pilot. The gas pilot in turn is used to start the main flame. The pilot flame is crucial to smooth ignition of the main flame. The length of the pilot flame is crucial to reliable ignition. The pilot flame needs to be of a length such that it will ignite the main flame very quickly to prevent the buildup of combustible fuel in the furnace. The pilot flame length increases with gas pressure supplied to it. The minimum possible gas pressure supplied to the pilot is guaranteed by the set point on the low gas pressure cutoff switch in the pilot fuel train. This set point should be about 80% of the regulated pilot gas pressure. The shortest pilot flame that will reliably ignite the main flame occurs at this minimum pilot gas pressure. Hence, a test to determine if the pilot length is adequate should be done at this minimum pilot gas pressure.

A complication exists in many situations for the backup fuel source for the pilot. Many systems normally use natural gas for the pilot fuel with propane or propane-air mixtures as the back up fuel. Natural gas and propane-air mixes should exhibit about the same burning characteristics. Propane has more energy per unit volume than natural gas and hence will have a different flame shape. If the situation being tested may involve both natural gas and propane as the pilot fuels, testing should be done to prove that the pilot flame is acceptable with either fuel. This test will also verify that the pilot can be successfully operated on either fuel.

5.14.2 Consequences of Inadequate Pilot Flame
Accidents commonly occur when boiler operators make multiple unsuccessful tries to ignite the fuel. Typically, these accidents involve introducing significant amounts of fuel into the boiler in several attempts to fire the main burner. If purging is not adequate, a point can easily be reached in which an explosive mixture of fuel is ignited. The massive explosion that often results usually causes severe property damage and personal injury and death in an area several hundred feet from the boiler. Even in the case of one try for main flame ignition, it must be remembered that if the igniter duration is too long, failure to quickly ignite the flame because of inadequate pilot flame length can cause a devastating explosion.

5.14.3 Testing for minimum pilot flame
The test involves setting the pilot gas pressure to a level just above the set point pressure on the low pilot gas cutoff switch. Then trials are made to see if the pilot can smoothly light both gas and oil. A detailed step by step procedure is given in Appendix A.

5.15 CONTROL AIR PRESSURE INTERLOCK

5.15.1 Description
Some older control systems use compressed air to operate various boiler controls. If air pressure is lost, the ability to regulate air and fuel flow into the boiler, feedwater flow, etc is lost. A control air pressure interlock switch that continuously measures air pressure in the air supply lines to the boiler controls is required. If the air pressure drops below a level necessary to operate the controls, the switch will trip and not allow the boiler to start, or if the boiler is running, will shut the boiler down. The person testing this switch should know the required air pressure specified by the control manufacturer and should adjust the setpoint pressure on the interlock to 120% of the minimum allowed pressure. An alarm to indicate problems at a pressure higher than the interlock setpoint is desirable.

5.15.2 Consequences of Failed Control Air Pressure Interlock Switch
Low control air pressure could easily result in a situation in which the air/fuel ratio moves into a situation where a furnace explosion could occur or dangerous levels of carbon monoxide is generated.

The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler. Also if the feedwater control valve is pneumatically operated, low control air pressure could result in the boiler running out of water with the problems described in section 2.1.2

5.15.3 Testing the Control Air Pressure Interlock

The test can be done with the boiler off. The control air pressure supplied to the switch can be reduced to just below the set point. At this condition the boiler should not start. A detailed step by step procedure is given in Appendix A.

5.16 FLUE GAS RE-CIRCULATION DAMPER SET FOR PRE-PURGE

5.16.1 Description

Some newer boilers are fitted with flue gas re-circulation in order to decrease NO_x levels produced in the combustion process. This system consists of a duct connected to the stack that re-circulates some flue gas into the incoming combustion air stream. There is a damper in this duct to control the amount of flue gas that is re-circulated. On the pre-purge cycle, it is necessary to insure that all combustible gases are purged from the re-circulation duct. Hence it is necessary to insure that the damper be in the wide-open position during purge. The flue gas re-circulation damper switch is used to show that the re-circulation damper is wide open for purge. This switch is of the proximity type. It is located such that the movement of the linkages moving the damper close the switch when the damper is in the wide-open position. The safest system would be a position switch actuated by the damper itself rather than at some point nearer the drive motor operating the damper.

5.16.2 Consequences of a Closed Flue Gas Recirculation Damper During Purge

If the pre-purge cycle does not eliminate all combustible gases from the system before the ignition sequence, a massive explosion could occur causing serious property damage, injury, and death within several hundred feet of the boiler.

5.16.3 Testing the Re-circulation Damper Interlock Switch

The re-circulation damper interlock switch should be tested during the boiler startup sequence. There are basically three things that should be tested:

- Is the switch the right type and located correctly?
- Is the switch “activated” at any position other than “wide open”?
- Does the switch with the damper in a non-activated position prevent the boiler from beginning the purge count

A detailed step by step procedure for testing the recirculation damper interlock switch is given in Appendix A.

5.17 LOW FLUE GAS OXYGEN LEVEL INTERLOCK

5.17.1 Description

The V.A. requires that all boilers have a low flue gas oxygen level alarm and interlock, which protects against firing with a “rich” fuel/air mixture. This system consists of using a zirconium oxide sensor in the stack to continuously measure oxygen. This signal is used to provide an alarm and interlock if the oxygen level falls below a setpoint. The setpoint should be as low as possible without the possibility of excessive CO and combustibles being present in the exhaust gas from the boiler. This interlock is electronically integrated into the burner management system for the boiler.

5.17.2 Consequences of a Failed Low Oxygen Alarm and Interlock

Insufficient combustion air results in flue gas with low oxygen and high combustibles which represent two very significant safety hazards. First, carbon monoxide will be a significant portion of the combustibles and can be fatal if breathed by humans at a sufficient level. Second, these combustible gases can produce a violent explosion if air is introduced. The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler.

5.17.3 Testing a Low Oxygen Alarm and Interlock

To properly test the alarm or cutoff it is necessary to know three things:

- Does the zirconium oxide sensor read the correct value?
- Has the trip point of the low oxygen interlock been set at the oxygen level at which the combustion is safe?
- Does the alarm interlock work? (i.e. provides an alarm and shuts the boiler down if levels below setpoint exist).

A detailed step by step procedure for the required test is given in Appendix A.

5.18 INTERLOCK OF OUTSIDE AIR DAMPER WITH BURNER MANAGEMENT SYSTEM

5.18.1 Description

Air for combustion must be available from the outside atmosphere (outside air) in the amount necessary to burn the fuel. Natural gas and oil require about 15 lb of air to burn 1 lb of fuel. The safety issue in this situation involves a scenario in which the outside air openings are closed to the point that insufficient air is supplied to the boiler. Boiler rooms can be placed into two distinct categories in terms of outside air supply. One type boiler room has so many leaks, open windows/vents/doors that there is no chance of starving the boiler for outside air. A second type boiler room is one in which normally there are a lot of openings to the outside but the possibility exists that these openings could be closed to a point where the boiler would be starved for air.

In the first type boiler room there is no need for an interlock because it is not possible to starve the boiler for air. In the second type boiler room there is generally no control to prevent the boiler from operating even though a potential danger exists. In this case, consideration of some method to prevent operation of the boiler with insufficient outside air should be given. Since generally there are several openings that must be closed to produce insufficient combustion air, no one position switch mounted at one of these openings will suffice to prevent the problem for all boilers. In some cases each boiler is provided combustion air through adjustable louvers with an interlock switch that prevents that boiler from being operated with the air intake louver closed. A cheaper solution is to permanently install sufficient area to provide the necessary outside air for all boilers by either welding or locking windows open or replacing windows with fixed air intake louvers.

5.18.2 Consequences of Inadequate Outside Air

This situation will cause high levels of combustibles in the boiler. High combustibles represent two very significant safety hazards. First, carbon monoxide will be a significant portion of the combustibles and can be fatal if breathed by humans at a sufficient level. Second, these combustible gases can produce a violent explosion if air is introduced. The explosion and toxic fumes that can be generated in this way could easily damage property and injure/kill people within hundreds of feet from the boiler.

5.18.3 Testing the Outside Air Damper Switch

Basically, the test involves determining whether sufficient outside air openings are guaranteed and sufficiently sized. If an outside air damper switch is used to make that guarantee, it can be simply tested by trying to start the boiler with the outside air damper closed. A detailed step by step procedure is given in Appendix A.

Appendix A   STEP BY STEP TEST PROCEDURES

Appendix A.1 INTRODUCTION

This appendix presents step by step test procedures for each safety device. The appendix provides forms for obtaining and recording all necessary data for each safety device being tested. It begins with tables that allow a thorough definition of the testing agency/personnel, responsible parties at the site, and boiler/burner data. This base data is followed by overarching requirements for safety testing. This information is then followed by one sheet for each device being tested to be used by the testing agency personnel as a check list and data form.

Appendix A.2   BASIC INFORMATION

VISN: ______________________________________
VA Medical Center: ________________________
Contact Name: _____________________________
Phone: ______________________________________
Email: ______________________________________
Evaluators: _________________________________
Date: _______________________________________

Individuals in Attendance:

Boiler and Burner Description

Boiler #	
Manufacturer:	
Model and Capacity:	
Serial #: National Board No.:	
Typical Operating Pressure:	
Design Pressure:	
Date of Manufacture:	
Boiler Controls:	
Burner	
Manufacturer:	
Type of burner:	
Fuels:	
Date of Manufacture:	

Appendix A.3 GENERAL REQUIREMENTS FOR TESTING

The following test procedures make certain assumptions that are listed below.

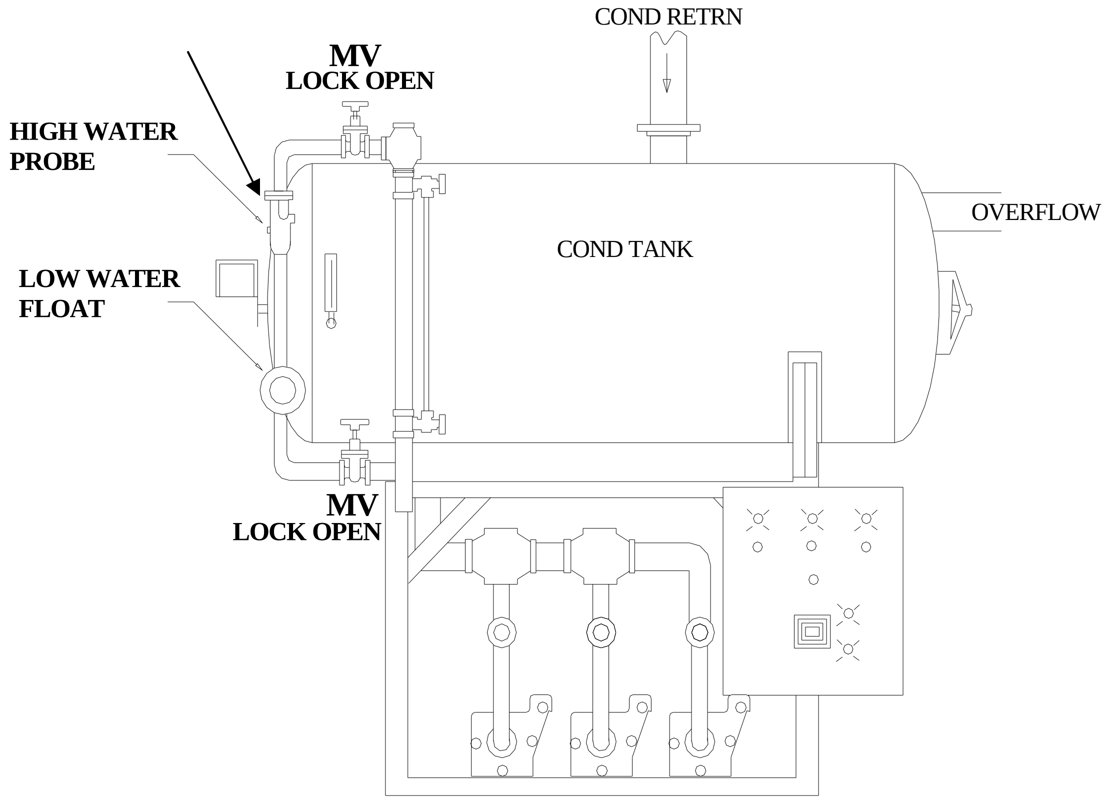
- After each test, equipment should be returned to normal operating condition and the boiler should be fired to confirm its operability.
- "Jumping" means disabling the switch electrically
- Any electric "jumper" application requires that all power to the device being "jumpered" be shut off.
- All pressure gages used in a test must be recently calibrated.
- Any valve that disables a safety device should be lockable only in the operating position.
- The setpoint is the value at which the switch indicator is set. The trip point is the actual value at which the switch activates. Some language used in the test procedures assumes that the setpoint equals the trip point.
- Potentiometers used as safeties should be evaluated to determine if they are also used as the control. This is not acceptable.

Appendix A.4 Detailed Test Procedures - Checklists

Checklist for High Water Alarm on Condensate Tank (HWACT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
HWACT					

*Alarm setpoint should be below 2/3rds of tank height & at least 4” below the overflow.
*Alarm type should be a probe sensor.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Use bypass valve to add water to the condensate tank at a rate not to exceed 1 inch per minute. Use water level sight glass to observe point that alarm sounds. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.
- Put maximum water supply to condensate tank and verify overflow is adequate.

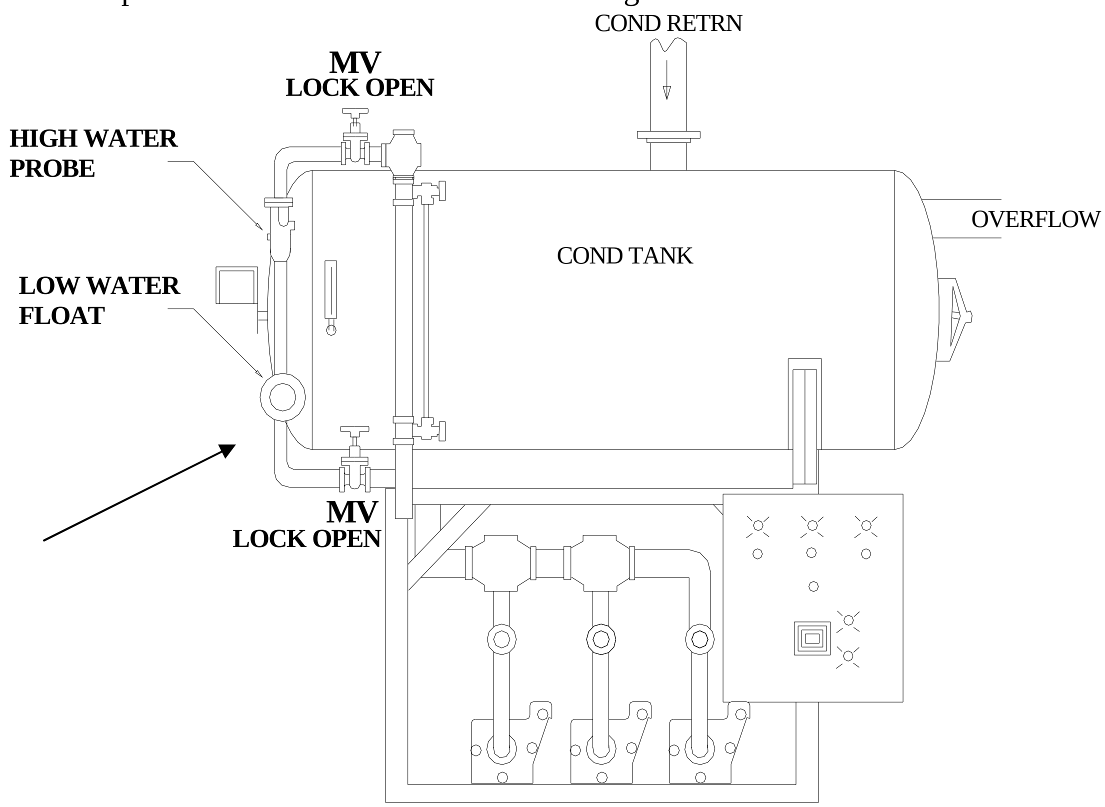
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Is overflow adequate?		
Can the switch be isolated with manual valves		

Comment:

Checklist for Low Water Alarm on Condensate Tank (LWACT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
LWACT					

*Alarm set point should be above 1/3rd of tank height?



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Drain the water from the condensate tank at a rate not to exceeded 1 inch per minute. Use water level sight glass to observe alarm point. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS

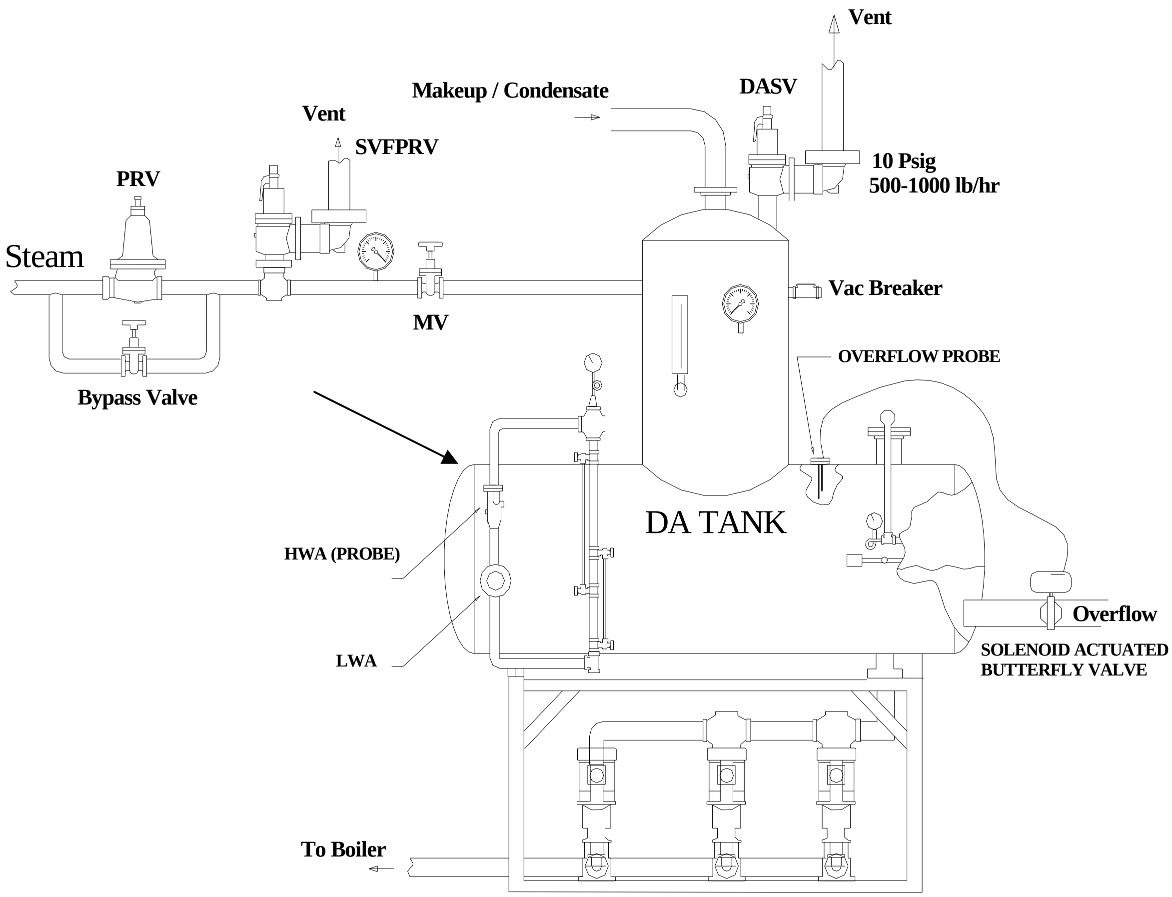
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

Comment:

Checklist for High Water Alarm on Deaerator Tank (HWADT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
HWADT					

*Alarm setpoint should be below 2/3rds of tank height & at least 4" below the overflow.
*Alarm type should be a probe sensor.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Use bypass valve to add water to the deaerator at a rate not to exceed 1 inch per minute. Use water level sight glass to observe point that alarm sounds. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.

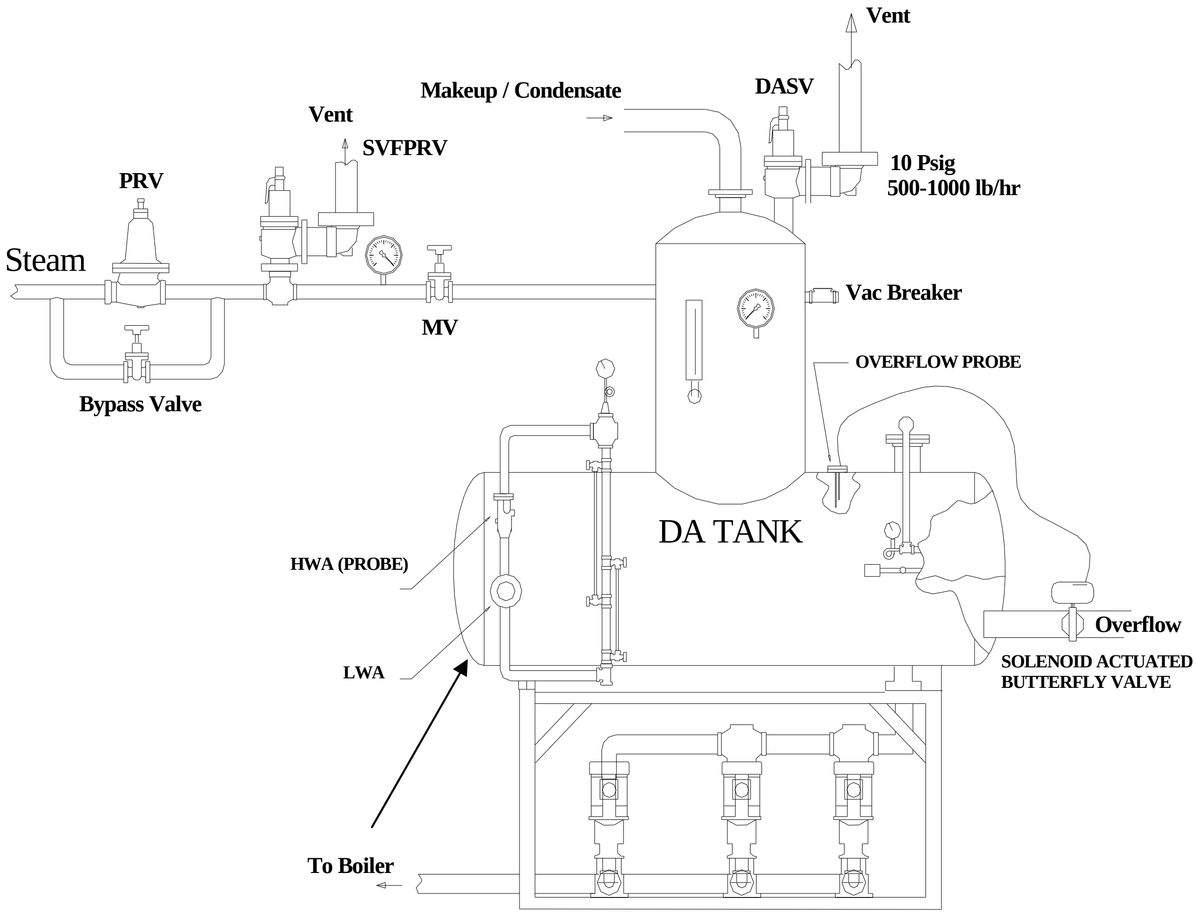
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

Comment:

Checklist for Low Water Alarm on Deaerator Tank (LWADT)

Item	Make	Float / Probe	Alarm Setpoint	Correct Device Type Y / N	Correct Location Y / N
LWADT					

*Alarm set point should be above 1/3rd of tank height.



- Drain the sight glass and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Drain the water from the deaerator at a rate not to exceed 1 inch per minute. Use water level sight glass to observe alarm point DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.

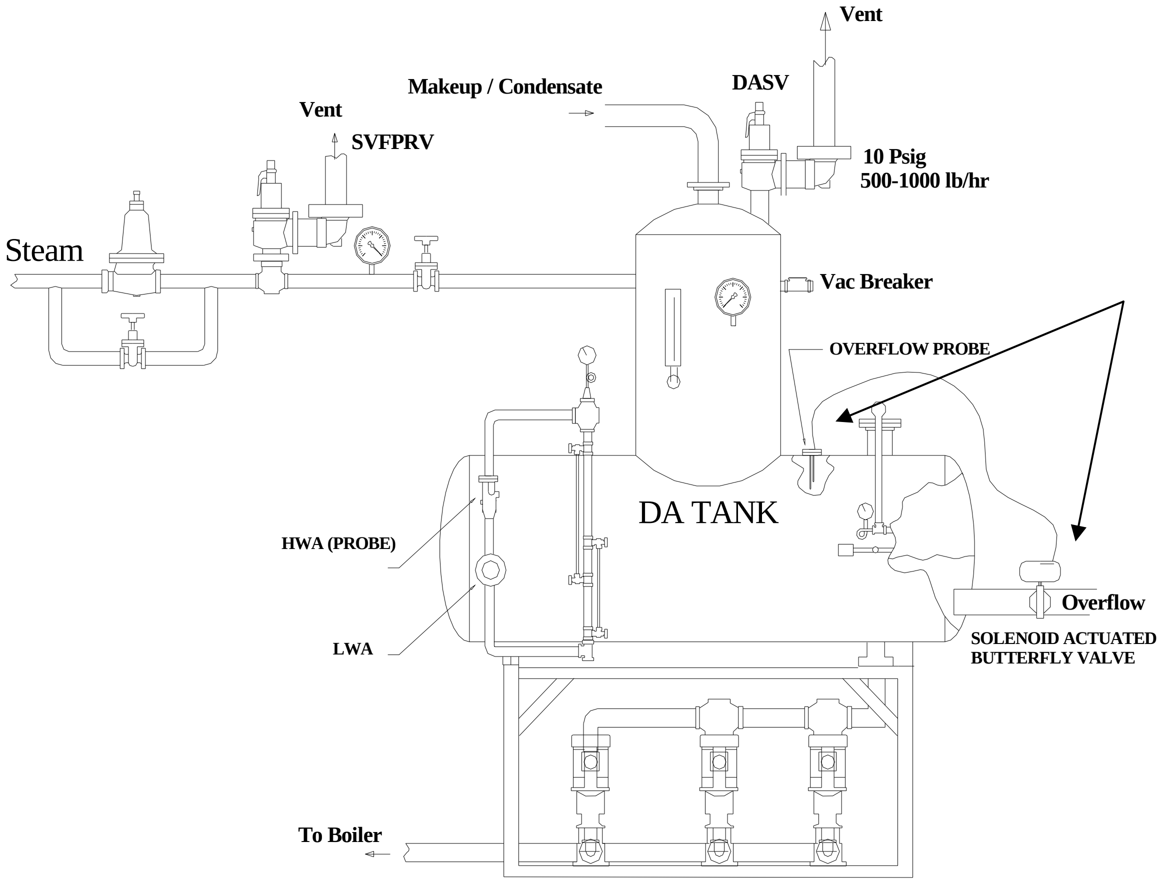
Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		
Can the switch be isolated with manual valves		

Comment:

Checklist for Deaerator Overflow Drain System (DAODS)

Item	Make	Float / Probe	Overflow Setpoint	Correct Device Type Y / N	Correct Location Y / N
DAODS					

*Overflow type should be a conductivity probe connected to electronic valve.
*Setpoint should be at least 4" below top of tank.



- Drain the sight glass and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- Open manual bypass valve to supply feedwater at maximum rate.
- Use sight glass in drain system to determine that dump valve has opened. Use water level sight glass to observe whether dump valve maintains water level visible in sight glass. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS.

Result	Y/N	Water Level
Did the overflow valve work correctly?		
Was the water level maintained in sight glass.		
View port in place to view overflow?		

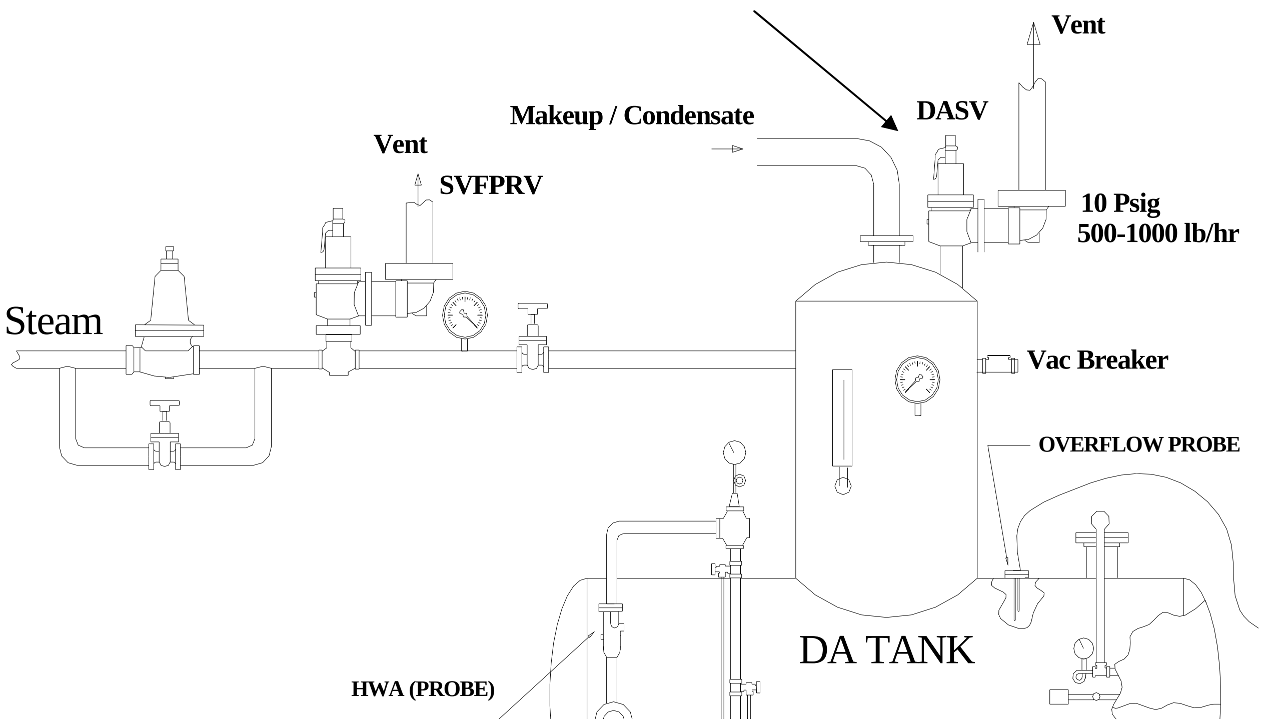
Comment:

Checklist for Deaerator Safety Valve (DASV)

Item	Make	Capacity (lb/hr)	Range	DASV Setpoint	DA PRES (psig)	Correct Installation
DASV						
Pressure Gage						

*Setpoint should be about 5 PSIG higher than DA pressure
*Capacity should be approximately (1000 lb/hr)

Item	Make	Type	MAWP	NDT (date)
Deaerator				



- Abort testing if NDT is not current within six years.
- Pour water into drip pan ell drain and confirm that it is open.
- Slowly open bypass valve to raise pressure until safety lifts. DO NOT RAISE PRESSURE MORE THAN 2 PSIG ABOVE SET POINT PRESSURE.
- Re-seat pressure should be about 6% less than lift pressure.
- After lifting valve, close bypass valve and allow safety to reseat.

Result	Y/N	Pressure
Did the safety valve work correctly?		
What was the safety valve relief pressure?		
What is the re-seat pressure?		
Is vacuum breaker present (VA requirement)?		

Comment:

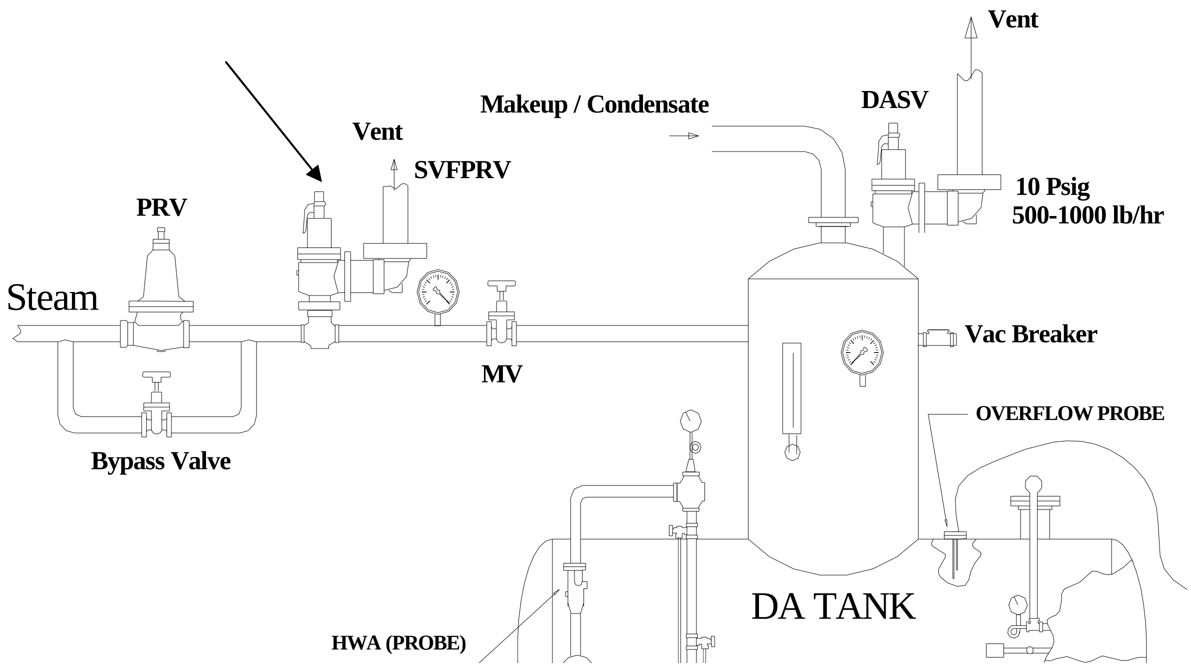
Checklist for Safety Valve Following PRV (SVFPRV) - Steam

Item	Make	Capacity (lb/hr)	Range	SVFPRV Setpoint	DA PRES (psig)	Correct Installation
SVFPRV						
Pressure Gage						

*Setpoint should be about 5 PSIG higher than DA safety lift point.

Item	Make/ Type	Size (in)	Pressure upstream	Pressure downstream	Wide Open Flow Capacity lb/hr
PRV					
Bypass					

*SVFPRV must relieve largest wide open flow capacity, PRV or bypass valve.



- Pour water into drip pan ell drain and confirm that it is open.
- Close the manual valve in steam line following the safety valve.
- Slowly open bypass valve to raise pressure until safety lifts. DO NOT RAISE PRESSURE MORE THAN 2 PSIG ABOVE SETPOINT PRESSURE.
- Re-seat pressure should be about 6% less than lift pressure.
- Open lager of the bypass valve or PRV completely and perform accumulation test. The pressure should rise no more than 6% above the setpoint pressure.
- After lifting valve, close bypass valve, open manual valve in steam line after PRV and allow safety to reseat.

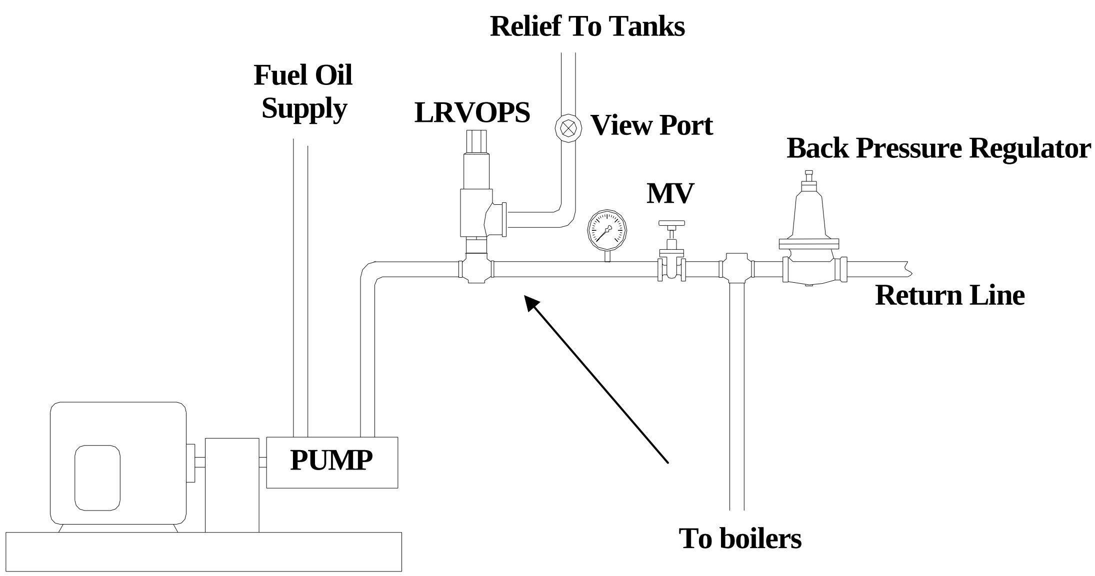
Result	Y/N	Pressure
Did the safety valve work correctly?		
What was the safety valve relief pressure?		
What is the re-seat pressure?		

Comment:

Checklist for Liquid Relief Valve on Oil Pump Set (LRVOPS)

Item	Make	Capacity (gal/hr)	Range	LRVOPS Setpoint	Oil Supply Pressure	Correct Installation
LRVOPS						
Pressure Gage						

*Setpoint should be less than the max allowable pump pressure and less than 10 psig above normal regulated oil supply pressure.
* Liquid relief should not be used as a backpressure regulator.



- Slowly close manual valve in oil line after relief valve or raise pressure regulator set pressure until relief valve lifts (use view port to determine if valve is open).
- The pressure should rise no more than 10 psig above normal regulated oil supply pressure.

Result	Y/N	Pressure
Did the relief valve work correctly?		
What was the safety valve relief pressure?		
Did valve re-seat?		
View port in place to view oil flow thru relief valve?		
Is a back pressure regulator present?		

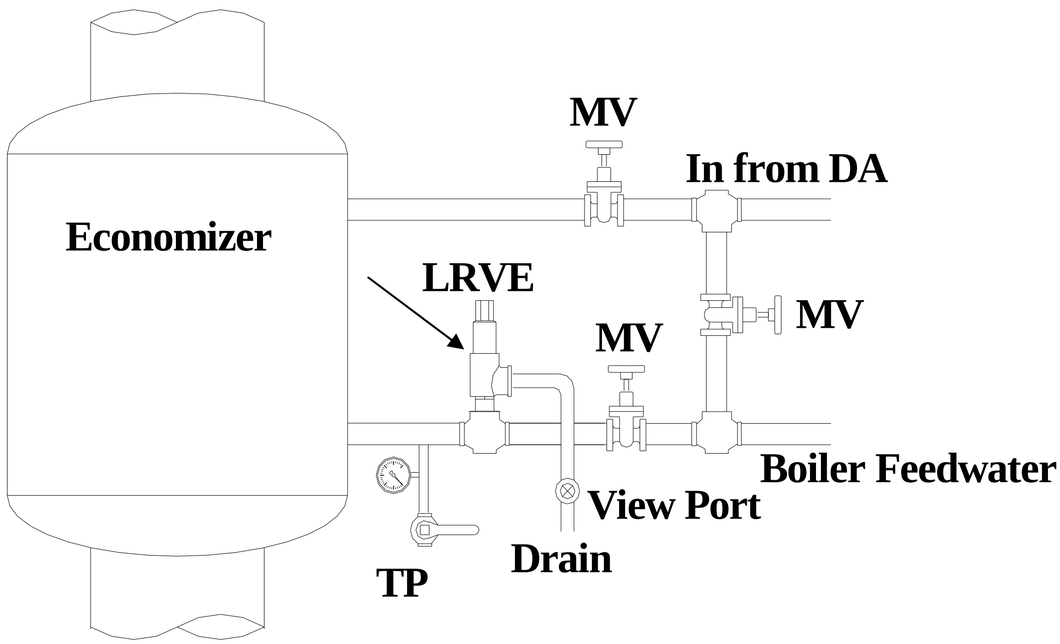
Comment:

Checklist for Liquid Relief Valve on Economizer (LRVE)

Item	Make	Capacity (gal/hr)	Range	LRVE Setpoint	Feedwater Pressure	Correct Installation
LRVE						
Pressure Gage						

*Setpoint should be less than the max allowable economizer pressure and more than maximum feedwater pressure.

Item	Make	Max Stack Temp	MAWP
Economizer			



- With boiler offline use manual valves to isolate economizer and relief valve. Use hydrostatic tester to raise pressure and open relief valve (use view port to determine when valve is open). DO NOT RAISE PRESSURE MORE THAN ALLOWABLE ECONOMIZER PRESSURE!
- An alternate method is to raise economizer pressure by operating boiler with isolation valves closed.

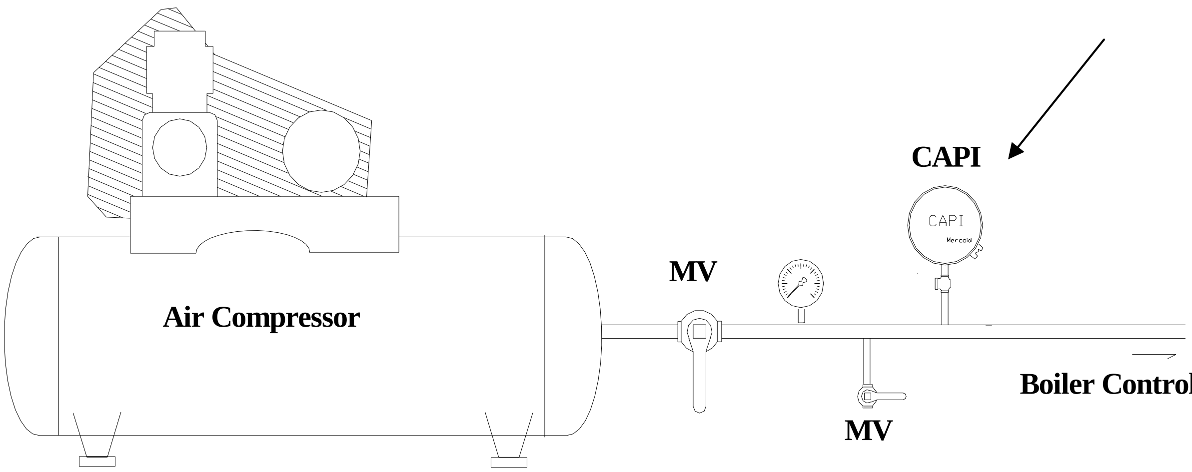
Result	Y/N	Pressure
Did the LRVE work correctly?		
What was the safety valve relief pressure?		
Maximum allowable economizer pressure?		
What is the re-seat pressure?		
View port in place to view water flow thru relief valve?		

Comment:

Checklist for Control Air Pressure Interlock (CAPI)

Item	Make	Range (psig)	Switch Setpoint	Regulated Pressure	Required Pressure	Correct Location Y/ N
CAPI						
Pressure Gage						

*Setpoint should be more than pressure required to actuate any pneumatic control device.



- Slowly close manual test valve to lower air supply pressure. Observe the pressure at which boiler shuts down. DO NOT LOWER PRESSURE BELOW REQUIRED PRESSURE TO ACTUATE ANY PNEUMATIC CONTROL DEVICE!

Result	Y/N	Trip Point
Did the CAPI work correctly?		
Is a lockable manual test valve in place as shown in figure?		
What was the interlock trip point?		
Is the setpoint higher than pressure required to actuate any pneumatic control device		

Comment:

Checklist for Propane Pilot Backup System

- Connect and/or align propane system to boiler.
- Attempt to light boiler FIRING ON FUEL OIL.

Result	Y/N
Is system in place and operable?	

Comment:

Checklist for Carbon Monoxide and Combustible Gas Alarms in the Boiler Plant

Item	Make	Number of Alarms	Alarm Setpoint	Test Gas Y/N	Correct Location Y / N
Combustible Alarm					
CO Alarm					

*CO setpoint should be 50 ppm or less.
*Combustible setpoints should be 10% or less of the LEL.
*Test gasses for CO and combustibles should be 225-250 ppm.
*Location and number of CO and combustible sensors determined by VA directive.

- Supply proper test in accordance with manufacturers recommendation to test alarms.

Result	Y/N
Did the combustibles alarm work correctly?	
Did the CO alarm work correctly?	
Are the number and locations of the sensors adequate?	

Comment:

Checklist for Outside Air Damper Interlock (OADI)

- If OADI exists, close outside air damper and prove that interlock shuts off boiler.
- If OADI does not exist measure fixed air intake area (fixed area required is 1.5 times the total combustion inlet air area for all boilers).

Result	Y/N	Manufacturer
Is there adequate FIXED opening to supply combustion air?		
If there is not adequate fixed opening, is there and OADI?		
If OADI exists, did it work?		

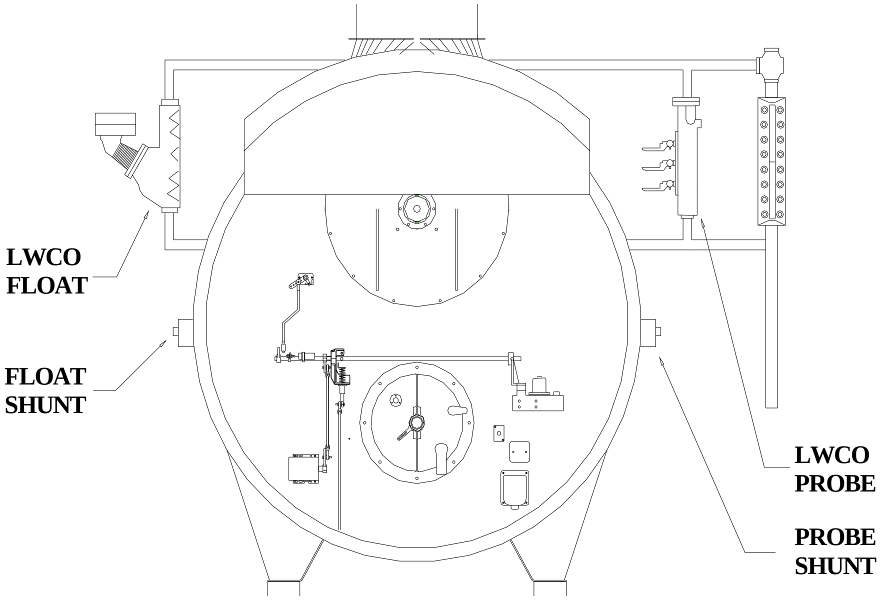
*Fixed intake area should be 1.5 times intake area for all boilers.

Comment:

Checklist for Low Water Alarm and Cutoffs on Boiler (LWA/LWCO/ALWCO)

Item	Make	Float / Probe	Correct Installation
LWA			
LWCO			
ALWCO			

*Independent shunt switches should be installed for each LWCO



- IN PERFORMING TEST NEVER LET WATER LEVEL LEAVE SIGHT GLASS!!!
- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler in manual at low fire, close the feedwater valve to generate a slow drain. You may "crack" the blowdown valve but do not exceed a drain rate of 1 inch per minute. Use water level in sight glass to observe alarm point. The alarm should sound first.
- Continue to drain until the primary cutoff activates.
- If shunt exists verify that it **ONLY** isolates the LWCO.
- Jumper or shunt the primary cutoff, restart the boiler, and set up drain as described above.
- Continue the drain until the secondary cutoff activates.

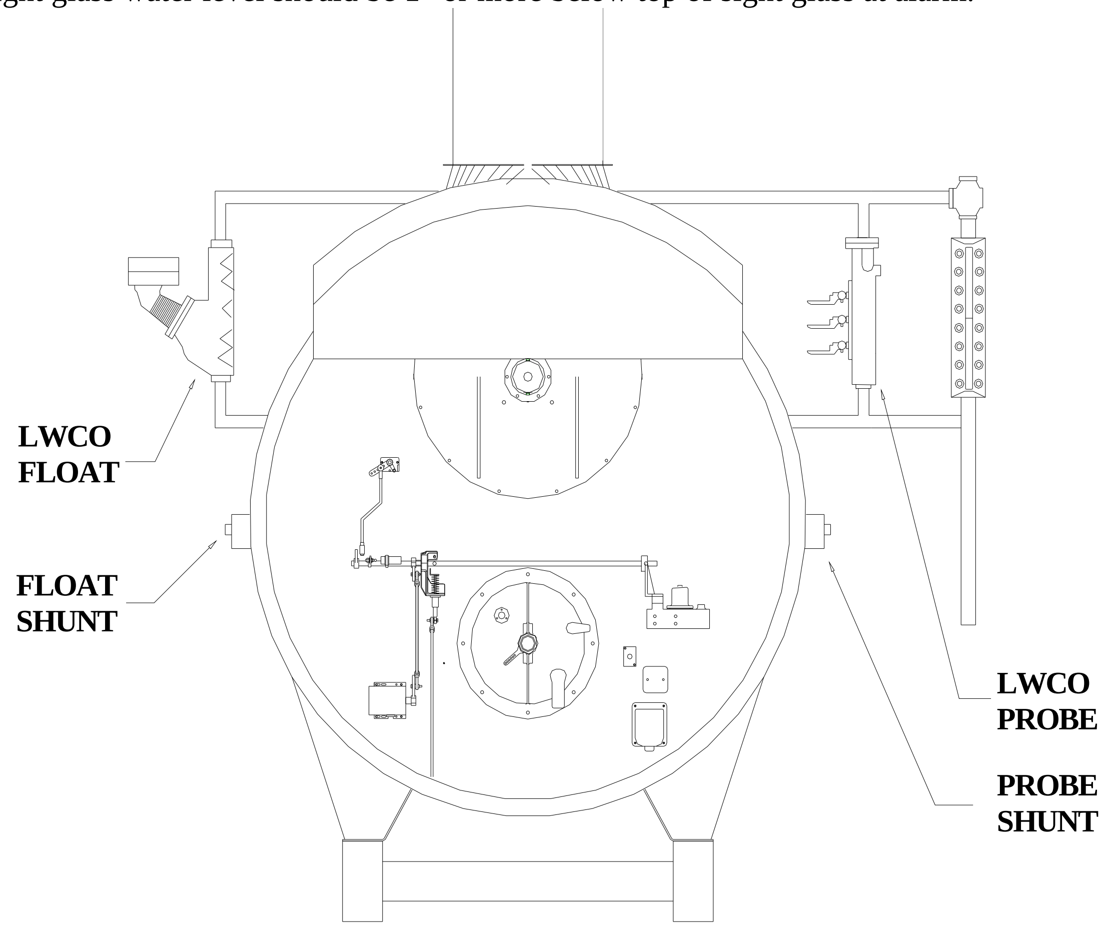
Result	Y/N	Water Level
Did the LWA work correctly? Record Level.		
Did the Primary cutoff work correctly? Record Level.		
Did the secondary cutoff work correctly?		
Was the alarm point above the primary and secondary cutoff point?		
Overall, did alarm and 2 low water cutoffs work correctly?		

Comment:

Checklist for High Water Alarm on Boiler (HWAB)

Item	Make	Float / Probe	Correct Installation
HWA			

*Sight glass water level should be 1” or more below top of sight glass at alarm.



- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler off, open the bypass feedwater valve to fill the boiler. Use water level in sight glass to observe alarm point. The alarm should sound before water level leaves sight glass. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS
- Close the bypass on feedwater line

Result	Y/N	Water Level
Did the alarm work correctly?		
What was the water level in sight glass at alarm point?		

Comment:

Checklist for Recycle and Non-Recycle Boiler Steam Pressure Limit Switches (RBSPLS & NRBSPLS)

Item	Make	Range (psig)	Switch Setpoint	Normal Steam Pressure (psig)	Lowest SVB Setpoint (psig)	Correct Setpoint Y / N
RBSPLS						
NRBSPLS						
Pressure Gage						

*RBSPLS setpoint should be 10 psig or more of normal steam pressure.
*NRBSPLS setpoint should be 5 psig or more of the RBSPLS setpoint & 5 psig or more less than the lowest SVB setpoint.

- Never exceed the boiler MAWP during this test.
- Place boiler in minimum fire and manually close the steam supply valves from the boiler.
- Raise the steam pressure slowly by firing the boiler.
- Raise until RBSPLS activates – record activation pressure in table below.
- Jumper the recycle switch out of the circuit.
- Fire boiler and raise the steam pressure slowly.
- Raise until NRSBPLS activates – record activation pressure in table below .

Result	Y/N	Pressure
Did the RBSPLS work correctly? Record Pressure.		
Did the NRSBPLS work properly? Record Pressure.		

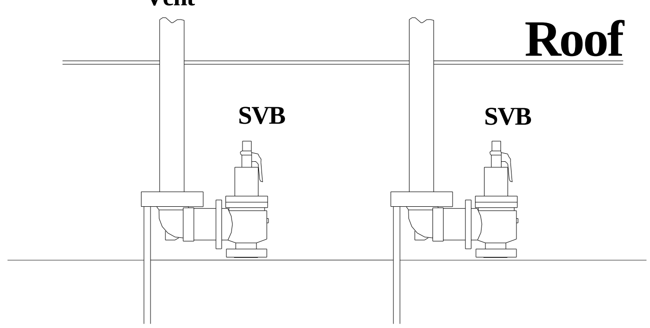
Comment:

Checklist for Steam Safety Valves on Boiler (SVB)

Item	Make	Capacity (Lb/hr)	Range	SVB Setpoint	Normal Steam Pressure	Correct Installation / Capacity
SVB 1						
SVB 2						
SVB 3						
Pressure Gage						

*SVB1 should be set 5 psig higher than NRBSPLS & 10 psig below boiler MAWP.
*SVB2 should be set 5 psig or higher than SVB1 & 5 psig or more below boiler MAWP.

Item	MAWP (psig)	Capacity (lb/hr)
Boiler		



- NEVER ALLOW BOILER PRESSURE TO EXCEEDE MAWP
- With boiler off, jumper recycle and non-recycle steam pressure switches.
- Close the steam supply valves from the boiler and test the drains on the safety valve drip pan ells by pouring water into them and noting that water flows freely. Unstop drains before proceeding.
- Raise the steam pressure slowly by firing the boiler at low fire.
- Note the pressure that the first & second safety valve opened. (may require increasing firing rate).
- Place boiler in high fire and determine if steam pressure rises with both SVB open.
- Shut boiler off and note the pressure that the safety valves close.

Result	Y/N	Lift (P)	Reseat (P)
Did the first SVB correctly? Record Pressure.			
Did the second SVB work correctly? Record Pressure.			
Did the third SVB work correctly? Record Pressure.			
Maximum pressure observed during accumulation test?			
Is SVB vent plumbing adequate?			

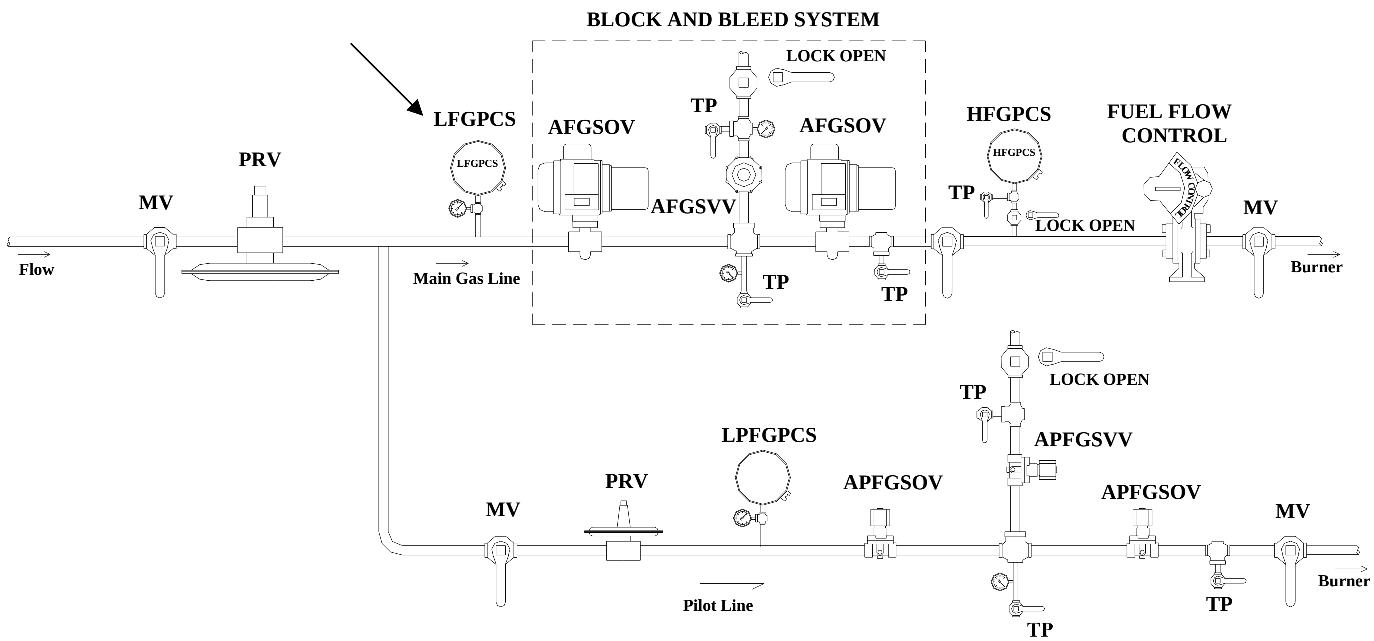
*Max lift pressure of 3% higher than rated lift pressure. Blowdown should be less than the greater of 2 psig or 2% of the set pressure, and shall not exceed 6% of set pressure.
*Maximum accumulation pressure seen should not exceed 110% of highest SVB setpoint and never exceed boiler rated pressure.

Comment:

Checklist for Low Fuel Gas Pressure Cutoff Switch (LFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint (inwc/ psig)	Regulated Pressure (inwc/psig)	Correct Location Y / N
LFGPCS					
Pressure Gage					

*LFGPCS must be downstream of PRV and upstream of AFGSOV with a setpoint of 80% or higher than regulated pressure.



In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but NO LOWER THAN 80% OF REGULATED PRESSURE

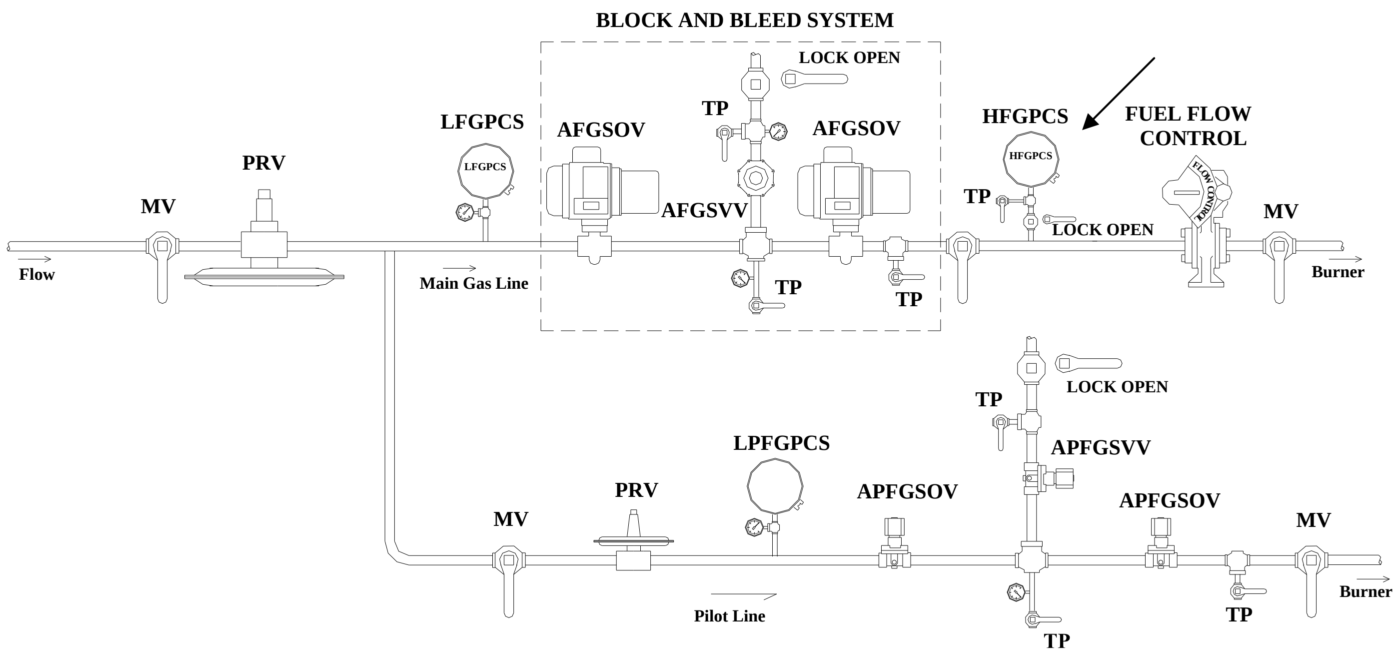
Result	Y/N	Pressure
Did the switch work correctly? Record pressure.		
Is switch trip point 80% or more of regulated pressure?		

Comment:

Checklist for High Fuel Gas Pressure Cutoff Switch (HFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint (inwc/ psig)	Regulated Pressure (inwc/psig)	Correct Location Y / N
HFGPCS					
Pressure Gage					

*HFGPCS must be downstream of PRV and upstream of flow control with a setpoint of less than 120% of regulated pressure.



- With boiler in low fire close lockable manual valve isolating the HFGPCS.
- Open test port between lockable manual valve and HFGPCS and pressurize with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high test gas pressure, BUT NO HIGHER THAN 120% OF REGULATED PRESSURE.

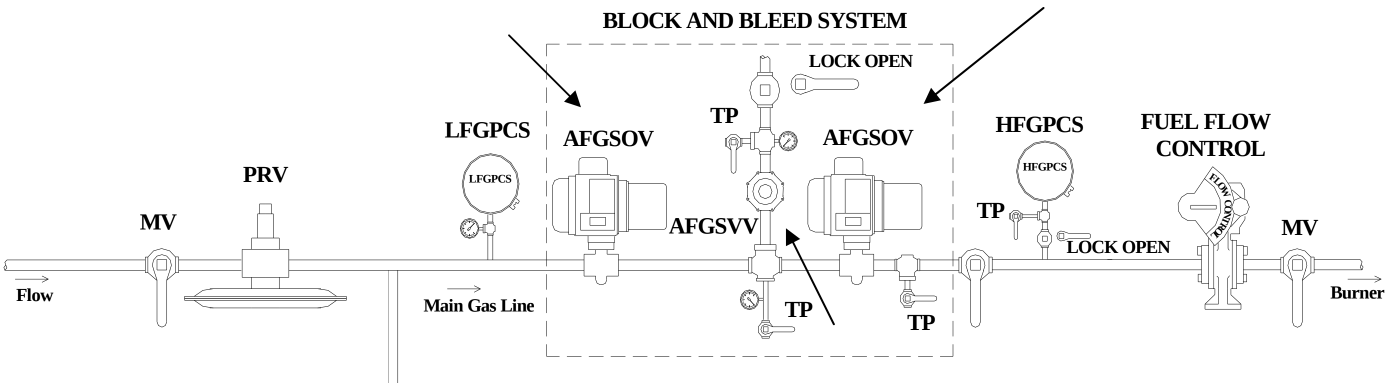
Result	Y/N	Switch Trip Point
Did the switch work correctly?		
Are manual test valves and test port valves in place as shown?		
What was the switch trip point?		
Is switch trip point 120% or less of regulated pressure?		

Comment:

Checklist for Automatic Fuel Gas Shutoff Valves and Solenoid Vent Valve Seat Leakage (AFGSOV & AFGSVV) – Main Gas Line

Item	Make	Range (inwc/psig)	Correct Installation Y/N
AFGSOV			
AFGSVV			
Pressure Gage			

*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open. Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water. This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line. Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream AFGSOV and between AFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between AFGSOV is atmospheric.

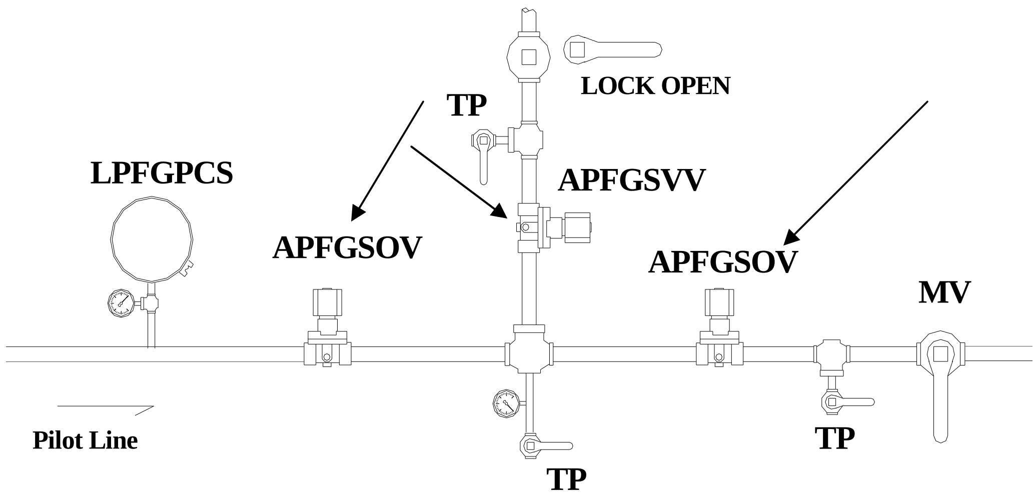
Result	Y/N
Did upstream AFGSOV leak?	
Did downstream AFGSOV leak?	
Did AFGSVV leak?	
Did AFGSVV open with boiler off	

Comment:

Checklist for Automatic Pilot Fuel Gas Shutoff Valves and Automatic Pilot Fuel Gas Solenoid Vent Valve Seat Leakage (APFGSOV & APFGSVV) – Pilot Line

Item	Make	Range (inwc/PSIG)	Correct Installation Y/N
APFGSOV			
APFGSVV			
Pressure Gage			

*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open. Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water. This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line. Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream APFGSOV and between APFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between APFGSOV is atmospheric.

Result	Y/N
Did upstream APFGSOV leak?	
Did downstream APFGSOV leak?	
Did APFGSVV leak?	
Did APFGSVV open with boiler off	

Comment:

Checklist for Proof of Closure on Automatic Fuel Shutoff Valves (POC-AFGSOV) – Natural Gas

Item	Make
POC-AFGSOV	

*Switch should open with a very slight opening of the valve.
*Switches should be wired in series.

- Close manual fuel valve downstream of AFGSOV. Perform the following test on each AFGSOV separately.
- Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box. Disconnect both leads from switch going to control circuit.
- Temporarily connect the two wires that were disconnected from the POC switch in order to electrically bypass the switch.
- Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
- Shut boiler down and disconnect two wires going to control circuit. Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
- Repeat procedure for switch on 2nd valve.

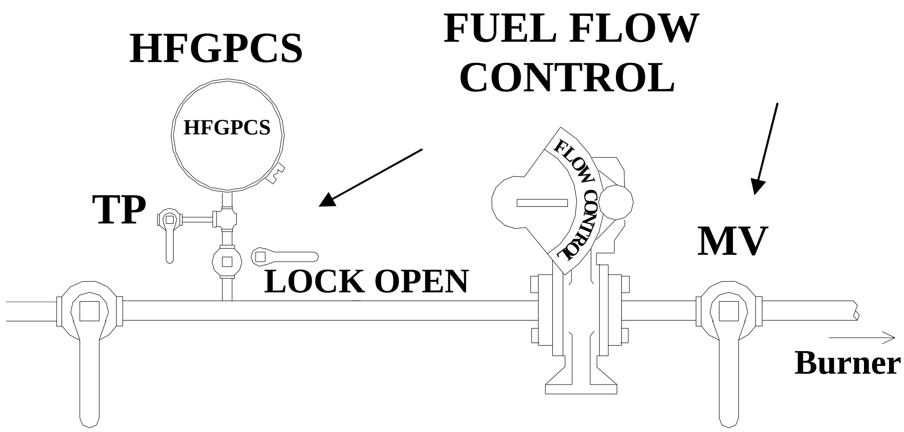
Result	Y/N
Is POC present in both valves?	
Did either valve being open allow the boiler to fire?	
Did both switches open with very slight opening of valve?	

Comment:

Checklist for Flame Scanner-for main flame out (FSMFO)

Item	Make	Model	UV or IR	Self-Checking Y/N	Correct Scanner Y/N
Flame Scanner					

*Maximum allowable timing is 4 sec.
*Only a UV– Self checking scanner is allowed. If scanner is IR, system must be replaced.



- Close the lockable manual valve between the fuel line and the HFGPCS.
- Quickly close the manual valve in fuel line before burner.
- Observe the time required for the flame scanner to close the automatic fuel safety shutoff valves. (Valves should close within 3 to 4 seconds from the time the flame goes out in the firebox).

Result	Y/N	Time (seconds)
Did the scanner work correctly?		
Time to close fuel valves?		

Comment:

Checklist for Flame Scanner Not Sensing Igniter Spark (FSNSIS)

Item	Make	Model	Rebuilt Y/N
Programmer			

*The scanner should not indicate a voltage-voltage indicates that scanner senses spark.

- Close manual valves in main fuel line and pilot gas line.
- Attempt to start boiler.
- Determine if the scanner output indicates a voltage.

Result	Y/N
Did the scanner work correctly?	

Comment:

Checklist for Igniter Timing (IT)

Item	Make	Model
Programmer		

* Maximum allowable duration is 10 sec.

- Close manual valves in main fuel line and pilot gas line.
- Start boiler.
- View igniter by means of furnace front or back view port and time the ignition spark. (You can hear the igniter click on and off so that it may not be necessary to view the spark if not easily visible).
- Observe the duration of the ignition spark with a stop watch.

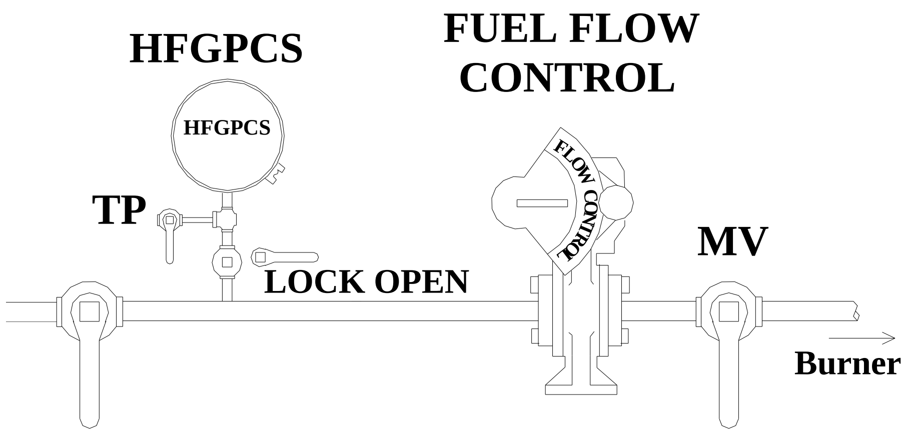
Result	Y/N	Time (seconds)
Did the scanner work correctly?		
Igniter timing?		

Comment:

Checklist for Main Flame Ignition Timing (MFIT)

Item	Make	Model
Programmer		

* Maximum timing should be 14 seconds.



- Close the lockable manual valve between the fuel line and the HFGPCS..
- Close manual valves in main fuel line.
- Attempt to start boiler.
- Time the AFGSOV from the time they begin to open until they close with a stopwatch.

Result	Y/N	Time (seconds)
Did the programmer work correctly?		
Time to AFGSOVs?		

Comment:

Checklist for Pre-Purge and Post-Purge Timing (PPT)

Item	Make	Model	Adjustable Timing Y/N
Purge Timer			

Boiler make	Fire Tube / Water tube	Boiler Fireside Volume (ft^3)

* Eight air changes are required for a water tube boiler and 4 air changes for a fire tube boiler.

- Begin firing boiler and record the pre-purge time in the table below.
- Repeat this step for post purge cycle.

Result	Time (sec)	Y/N
Low fire to high fire?		
Time in high fire?		
High fire to low fire?		
Time in post purge?		
Equivalent High Purge Time?		
Is purge adequate?		

*Equivalent purge is all time spent at high fire plus half of the time spent in getting to high fire and returning to low fire.

Comment:

Checklist for Low-Fire Proving Switch (LFPS)

Item	Make	Model
LFPS		

*Should not be made above a 5% point load increase above low fire.
*LFPS must be separate from the control system that modulates the firing rate.

- Measure the voltage across the switch during the purge cycle. (The switch should be closed at start up (no voltage) and should open with less than a 5% point increase in load).
- Disconnect one electrical lead from switch. Allow boiler to complete the purge cycle and return to low fire. Boiler should not start.

Result	Y/N	Switch Trip point
Did the switch work correctly?		
What was the switch trip point?		

Comment:

Checklist for Forced Draft Damper Wide-Open Pre-Purge Proving Switch (FDDWOPS)

Item	Make	Model
FDDWOPS		

* Must be open at positions lower than 90% of wide open (damper vanes).

- Measure the voltage across the switch during the purge cycle to determine if the switch is open or closed. Note load that switch closes.
- Disconnect one electrical lead from switch. Let boiler go through purge cycle. (Boiler should stay at high purge).

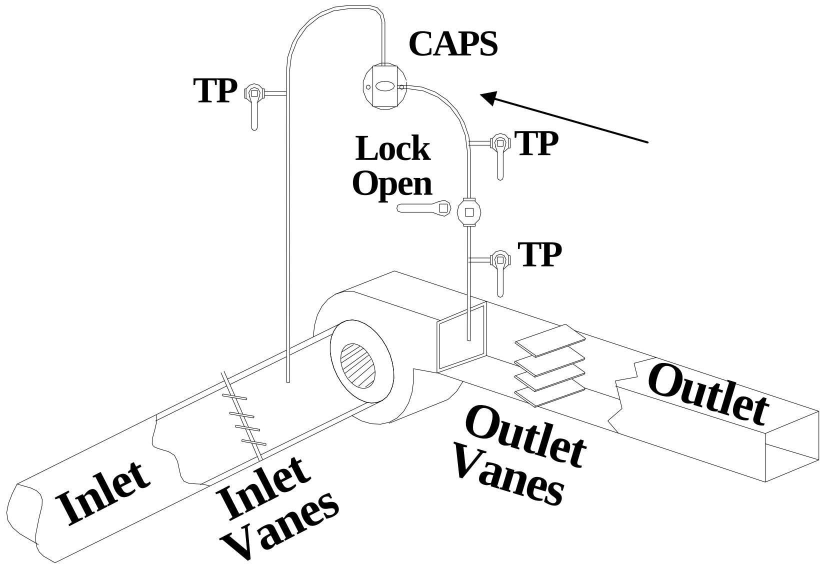
Result	Y/N	Load that switch closes.
Did the switch work correctly?		

Comment:

Checklist for Combustion Air Pressure Switch (CAPS)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Range (inwc)	Switch Setpoint (inwc)
CAPS					

*CAPS should open if pressure drops to 80% of minimum pressure difference.
* If the switch senses the correct pressure difference, the variation in pressure difference from low to high fire will vary only a few percent.



- Install appropriate flex tubing to a manometer from the test ports closest to CAPS to measure the pressure difference that the switch senses by opening the lockable test ports across the switch.
- Start the boiler and record the pressure difference read by manometer from the low fire to high fire position.
- Slowly allow the pressure to drop in the high pressure leg by using the test port closest to the fan outlet and observe the pressure at which the switch opens and shuts off boiler.
- It may be necessary to partially close the Lock Open valve to actuate the switch.
- Record value of pressure difference at which switch tripped.

Firing Rate	Pressure Difference (inwc)	Minimum Pressure Difference (inwc)	Switch Trip (Break) Point (inwc)
Low			
Med			
High			

*Switch trip point should be 80% of the minimum pressure difference.

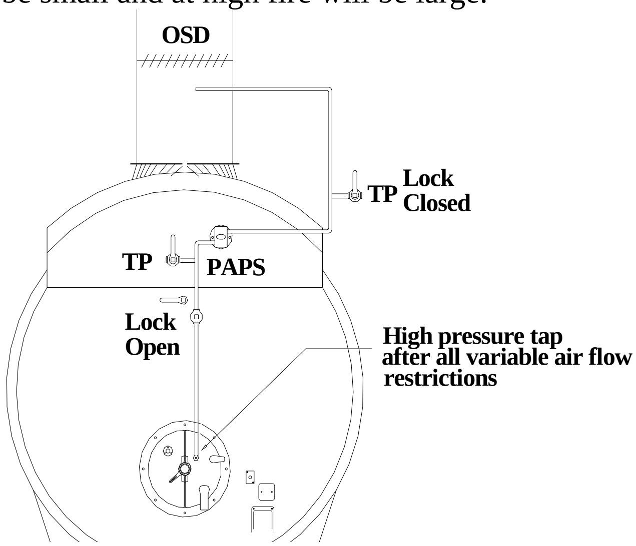
Result	Y/N	Switch Trip (Break) point (inwc)
Did the switch work correctly?		

Comment:

Checklist for Purge Airflow Proving Switch (PAPS)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Range (inwc)	Switch Setpoint (inwc)
PAPS					

*Should make at 80% maximum pressure signal.
* If the switch senses the correct pressure difference, the variation in pressure difference at low fire will be small and at high fire will be large.



- Connect a manometer to measure the pressure difference that the switch senses by opening the test ports across the switch and installing appropriate flex tubing to the manometer from the test ports.
- Start the boiler and record the pressure difference indicated by manometer from low fire to high fire positions.
- With boiler offline disconnect one lead from the PAPS.
- Close lock open valve and slowly pressurize the high pressure leg with air. Determine switch trip point using a manometer and measuring electrical resistance across the switch.
- With lock open valve open and high pressure leg test port open attempt to restart boiler. Boiler should hold in purge.
- Open lock open valve and close test port. Boiler should light.

Firing Rate	Pressure Difference	Maximum Pressure Difference (inwc)	Switch Trip (Make) Point (inwc)
Low			
Med			
High			

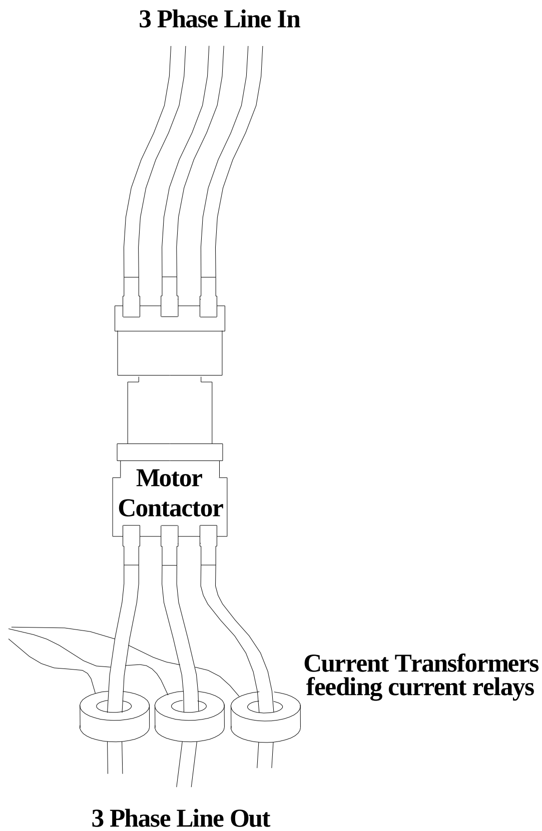
Result	Y/N	Switch Trip (Make) point (inwc)
Did the switch work correctly?		

Comment:

Checklist for Forced Draft Motor Interlock Switches (FDMIS)

Item	Make	Type of Switch: Aux. Contact Phase Monitor Current Relays
FDMIS		

*Current relays are the only acceptable FDMIS



- If current relays are not in place, abort test.
- With power to fan off, remove one electrical power lead to fan from terminal block and slip power lead out of the current transformer ring. Reconnect power lead to fan. (Note some "donut" rings are in form of a clamp and can be removed without disconnecting power lead).
- Attempt to start boiler. Boiler should shut down quickly.
- Repeat above process for each of three power leads to fan.

Result	Y/N
Did the switch work correctly?	

Comment:

Checklist for Outlet Stack Damper Interlock Switch (OSDI)

Item	Make
OSDI	

*Must be open if dampers are not at least 80% open.
*Not required if damper is welded in the wide open position and there are no other potential obstructions.

- Connect a multimeter across the switch and measure voltage.
- Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
- Stop boiler and turn off power to controls.
- Disconnect one lead from switch.
- Start boiler. The boiler should not complete purge sequence.

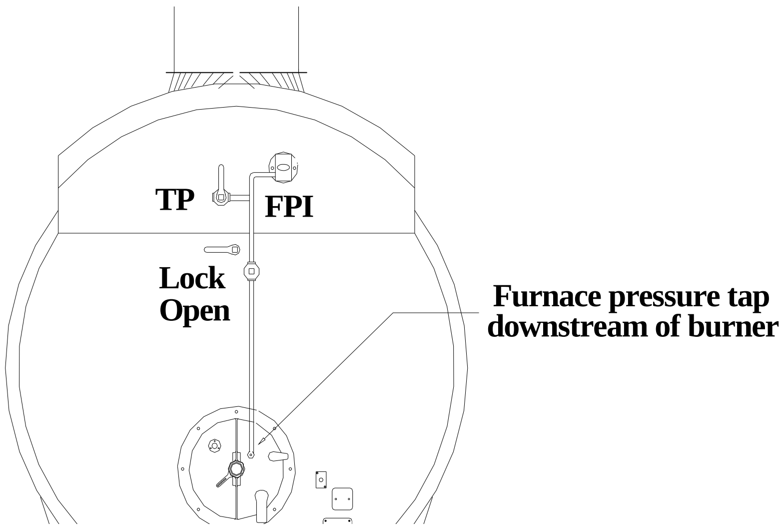
Result	Y/N
Did the switch work correctly?	

Comment:

Checklist for Furnace Pressure Interlock (FPI)

Item	Make	Low Pressure Tap Location	High Pressure Tap Location	Switch Setpoint (inwc)
FPI				

*Not required on boilers with no outlet stack damper or other possible obstructions in the flue gas outlet system.
*Required trip point is the greater of 1”wc or 20% above maximum boiler furnace pressure.



- Open the test port valve and connect a manometer using appropriate flex tubing to the high pressure test port with other side of manometer open to atmosphere.
- Start the boiler and record the pressure sensed by the switch over the entire firing rate.
- Return the boiler to low fire.
- Open the TP valve.
- Close manual lockable valve in high pressure leg.
- Connect flex tubing to TP.
- Slowly pressurize the switch.
- Note the pressure that the boiler trips off line.

Firing Rate	Pressure Difference	Maximum Pressure Difference (inwc)	Switch Trip Point (inwc)
High			
Mid			
Low			

* The boiler should trip off line at less than 120% of furnace pressure at high fire.

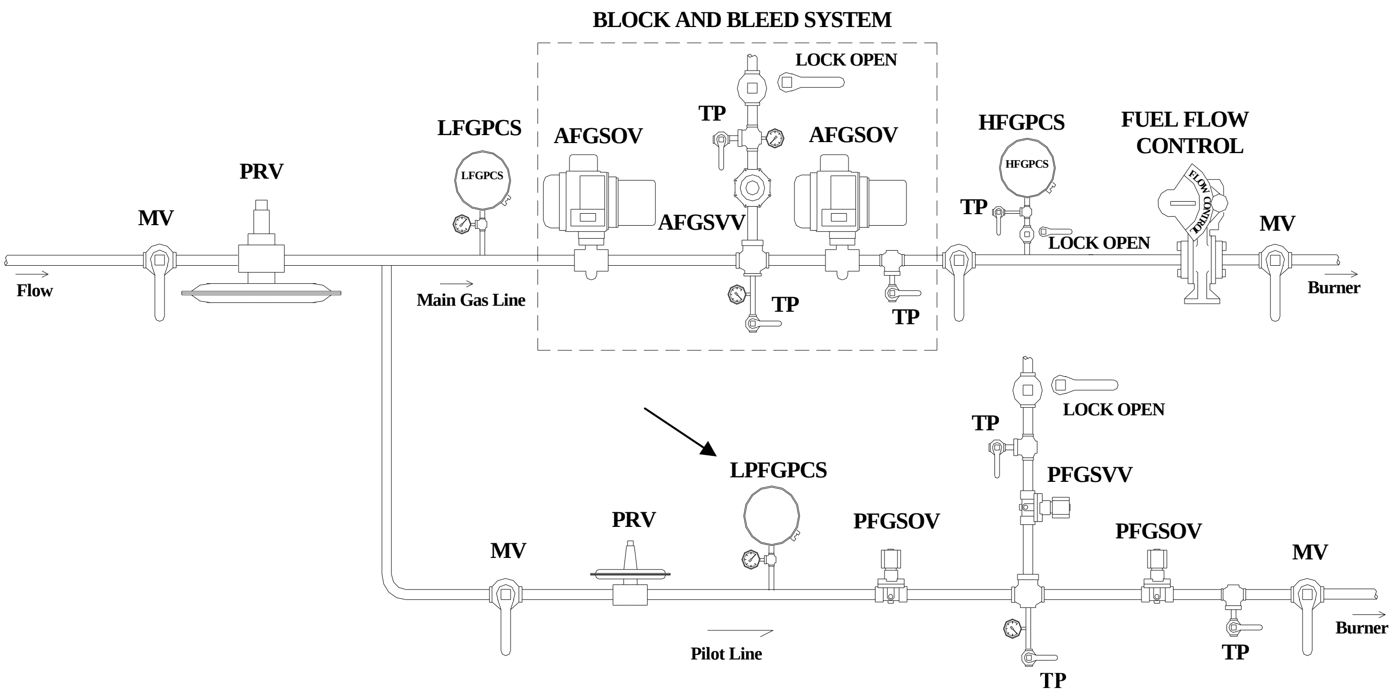
Result	Y/N	Switch Trip point
Did the switch work correctly?		

Comment:

Checklist for Low Pilot Fuel Gas Pressure Cutoff Switch (LPFGPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LPFGPCS					
Pressure Gage					

*Switch setpoint should be 80% of regulated pressure.



- Close the main fuel valve and allow the pilot burner to light and place programmer in check mode while holding in the pilot cycle.
- In low fire throttle manual valve upstream of the LPFGPCS slowly until switch trips the boiler offline due to low pilot fuel pressure.
- Open the pilot gas valve and again put boiler in check mode with pilot lit. Slowly close the pilot gas valve and regulate the pilot gas pressure to a value just above the trip point.
- Open the main gas valve, place the programmer in the "run" mode, and carefully observe that the main burner ignites immediately and smoothly.
- Be prepared to stop the burner immediately if this does not occur.

Result	Y/N	Switch Trip point
Did the boiler light smoothly with low pilot gas pressure?		

Comment:

Checklist for Flue Gas Recirculation Damper Interlock (FGRDI)

Item	Make
FGRDI	

*Open switch should prevent completion of the pre purge cycle.
*Dampers should be at least 80% open to close the switch.

- Connect a multimeter across the switch and measure voltage.
- Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
- Stop boiler and turn off power to controls
- Disconnect one lead from switch
- Start boiler. The boiler should not complete the purge sequence.

Result	Y/N	Switch Trip Point
Did the switch work correctly?		

Comment:

Checklist for Low Flue Gas Oxygen Level Interlock (LFGOLI)

Item	Make	Alarm or Interlock
LFGOLI		

*Low oxygen alarm only is inadequate and should be replaced with interlock and alarm.
*Interlock should prevent boiler from operating with more than 200 ppm CO or combustibles in the flue gass.

- Measure the property values listed in the table below.

% Load	Steam P (psig)	O_2(%)	CO (ppm)	EFF (%)	T-Stack	NOx	Economizer Temp IN	OUT
Low								
Med								
High								

- Use an flue gas analyzer to measure % O_2 and CO with the boiler at approximately 30% load.
- Slowly block the boiler air intake or increase fuel without increasing air. USE EXTREME CARE NOT TO CREATE A DANGEROUS CONDITION. NEVER ALLOW THE CO CONTENT OF FLUE GAS TO EXCEED 200 PPM!

Item	O_2% where interlock activated	CO (ppm) where interlock activates
LFGOLI		

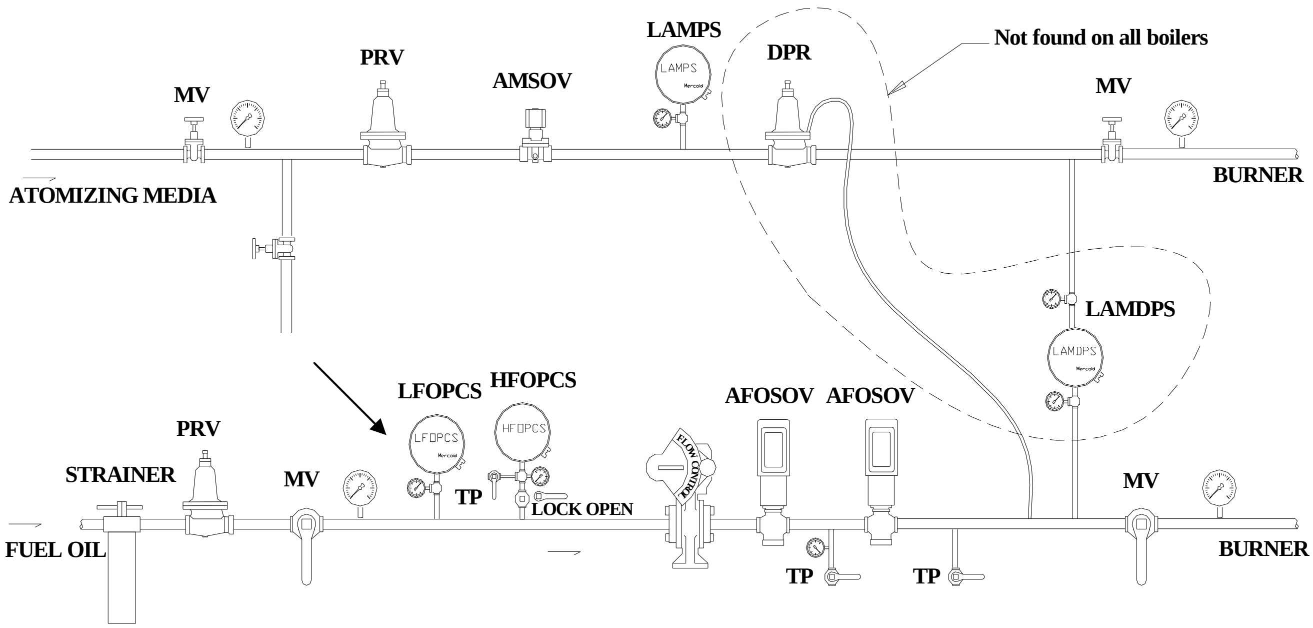
Result	Y/N
Did the interlock work correctly?	
Did the LFGOLI activate with less than 200 ppm of CO?	

Comment:

Checklist for Low Fuel Oil Pressure Cutoff Switch (LFOPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LFOPCS					
Pressure Gage					

*The LFOPCS location must be downstream of PRV and upstream of flow control valve.
*Trip point of LFOPCS should be equal to or greater than 90% of regulated pressure.



- In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but NO LOWER THAN 80% OF REGULATED PRESSURE.

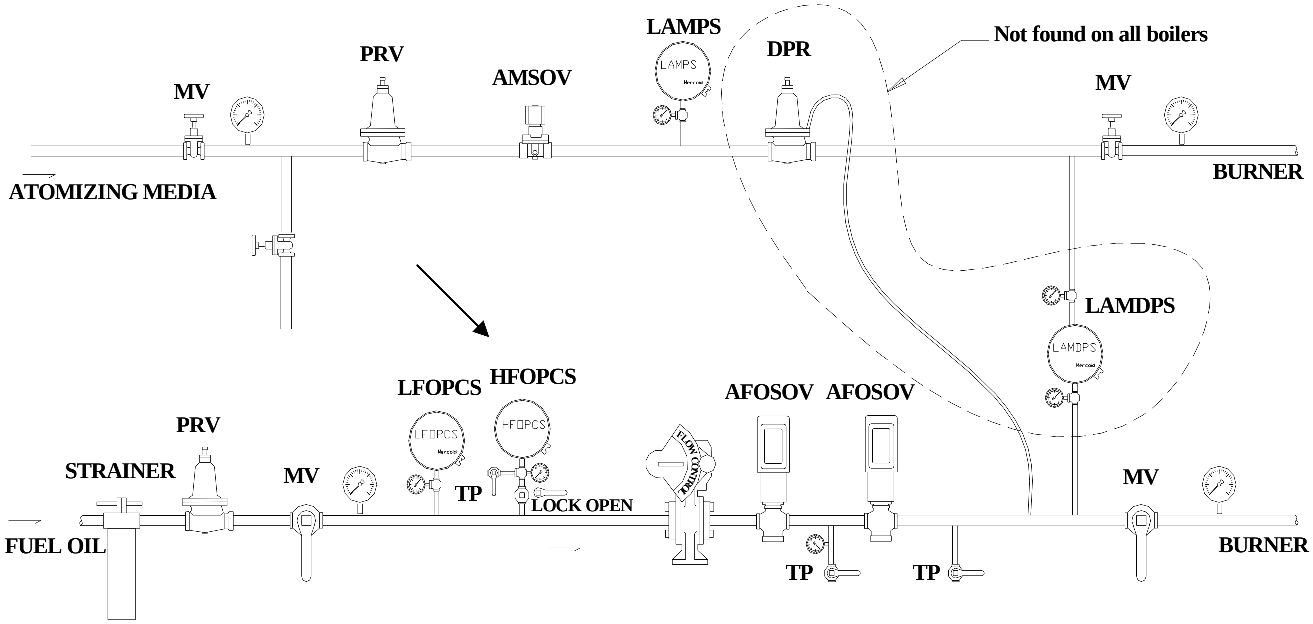
Result	Y/N	Switch Trip point
Did the switch work correctly?		
Is switch setpoint 90% or more of regulated pressure?		

Comment:

Checklist for High Fuel Oil Pressure Cutoff Switch (HFOPCS)

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
HFOPCS					
Pressure Gage					

*The HFOPCS location must be downstream of PRV and upstream of flow control valve.
*Trip point of HFOPCS should be equal to or less than 110% of regulated pressure.



- With boiler in low fire close lock open manual valve isolating the HFOPCS.
- Open test port between lockable manual valve and HFOPCS; pressurize switch with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high fuel pressure.

Result	Y/N	Switch Trip Point
Did the switch work correctly?		
Is switch setpoint 110% or less of regulated pressure?		

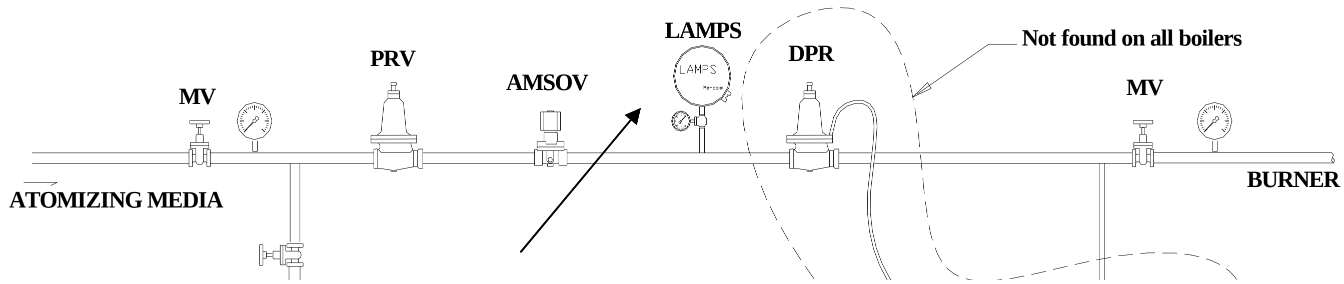
Comment:

Checklist for Low Atomizing Media Pressure Switch (LAMPS)

Item	Pressure
Atomizing media pressure at low fire	

Item	Make	Range (inwc/psig)	Switch Setpoint	Regulated Pressure	Correct Location Y/N
LAMPS					
Pressure Gage					

*Setpoint Should be 80% or more of atomizing media pressure at low fire



- Operate boiler and determine data in following table.

Item	Minimum Fire (psig)	Mid Fire (psig)	High Fire (psig)
Oil pressure at burner			
Atomizing Pressure at burner			
Oil pressure downstream PRV			
Atomizing pressure downstream PRV			

- In low fire throttle manual valve in atomizing media line before the switch slowly until switch trips the boiler offline due to low atomizing media pressure but NO LOWER THAN 80% OF ATOMIZING MEDIA PRESSURE AT LOW FIRE.

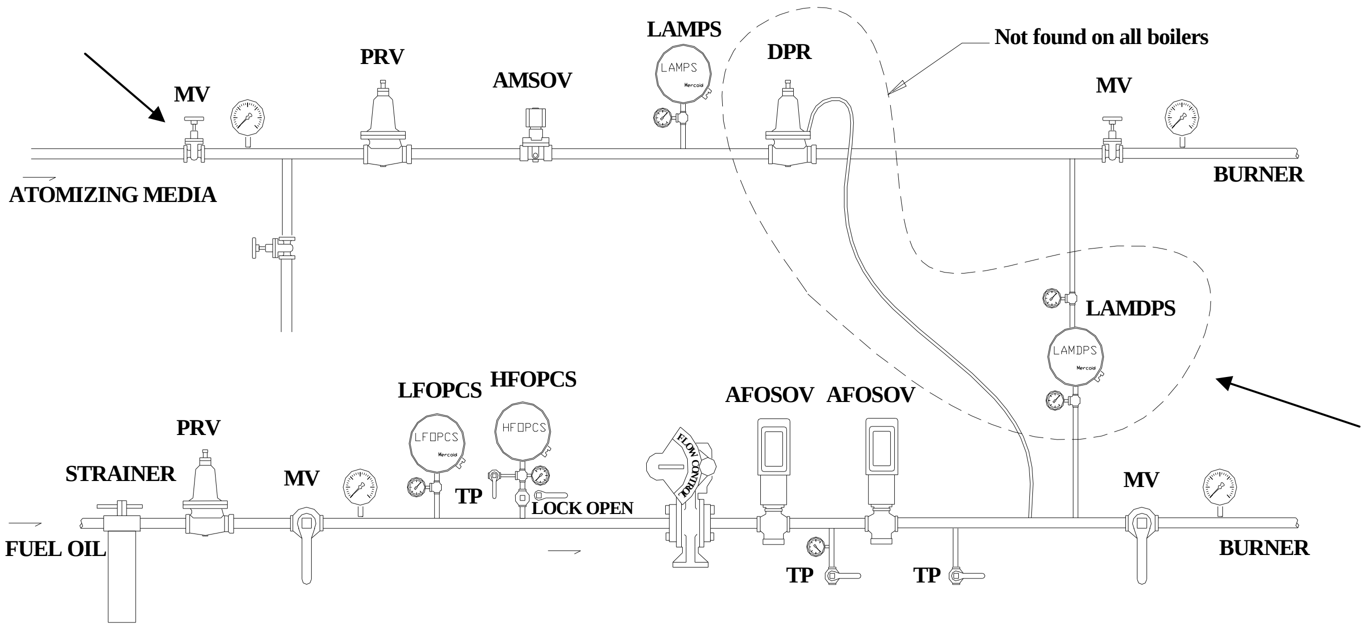
Result	Y/N	Switch Trip Point
Did the switch work correctly?		

Comment:

Checklist for Low Atomizing Media Differential Pressure Switch (LAMDPS)

Item	Make	Range (inwc/PSIG)	Switch Setpoint	Minimum Diff Pressure	Correct Location Y/N
LAMDPS					
Pressure Gage Fuel Oil Burner					
Pressure Gage Atomizing media					

*This switch is not required if oil pressure exceeds atomizing pressure at any firing rate.
*For this case the LOLI is the only protection against inadequate atomizing media.
*Setpoint should be 80% or more of minimum differential pressure between oil and atomizing media.



- Determine the minimum differential pressure from data table in LAMPS checklist and record in above table.
- In low fire throttle manual valve in atomizing media line before the LAMDPS slowly until switch trips the boiler offline due to low differential pressure but NO LOWER THAN 80% OF MINIMUM ATOMIZING MEDIA DIFFERENTIAL PRESSURE.

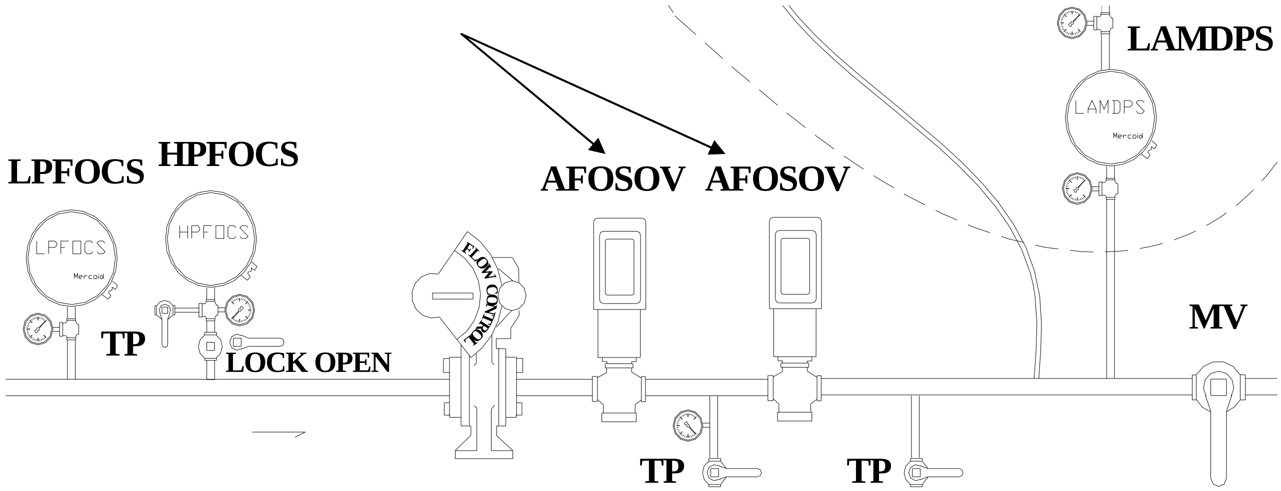
Result	Y/N	Switch Trip point
Did the switch work correctly?		

Comment:

Checklist for Automatic Fuel Oil Shutoff Valves (AFOSV) - for Seat Leakage

Item	Make	Range (inwc/psig)	Correct Installation Y/N
AFOSV			
Pressure Gage			

*After equilibrium is established, leak rate should be less than one drop in 10 seconds.



- While the boiler is firing quickly close the manual valve in oil line located after the automatic shut off valves.
- Place a container under the test port downstream of both automatic shut off valves. Open the downstream test port valve and observe oil flow. In order to consider the valve as not leaking, oil flow should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium. Make sure that the pressure gage between the 2 auto shut off valves indicates pressure approximately equal to regulated pressure or higher. If downstream shut off valve leaks this pressure will fall.
- Place a container under the test port between the automatic shut off valves. Open the downstream test port valve between the automatic shut off valves and observe oil flow. In order to consider the valve as not leaking, oil flow should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium.

Result	Y/N
Did upstream AFOSV leak?	
Did downstream AFOSF leak?	

Comment:

Checklist for Proof of Closure on Automatic Fuel Oil Shutoff Valves (POC-AFOSV) – Oil

Item	Make
POC-AFOSV	

*Switch should open with a very slight opening of the valve.
*Switches on the two valves must be wired in series.

- Close manual fuel valve downstream of AFOSOV. Perform the following test on each AFOSOV separately.
- Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box. Disconnect both leads from switch going to control circuit.
- Temporarily connect the wires disconnected from the POC switch in order to bypass the switch.
- Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
- Shut boiler down and disconnect two wires going to control circuit. Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
- Repeat procedure for switch on 2nd valve.

Result	Y/N
Is proof of closure present in both valves?	
Did either valve being open allow the boiler to fire?	
Did both switches open with very slight opening of valve?	

Comment:

Checklist for Oil Burner Position Switch (OBPS)

Item	Make
OBPS	

*If no switch is present this test is not required and test is complete.

- Retract the gun enough to disengage the switch. Attempt to start the boiler. The boiler controls should not allow the purge process to begin. IF BOILER BEGINS TO MOVE TO THE PURGE POSTION SHUT THE BOILER DOWN IMMEDIATELY. IN THIS CASE THE OBPS SWITCH IS DEFECTIVE.

Result	Y/N
Did the switch work correctly?	

Comment:

Checklist for Water Treatment

Sample	**TDS** ( )	**Sulfite** (ppm)	**Phosphate** (ppm)	**( )-Alk** (ppm)	**Hardness** (ppm)	**pH**
Boiler						
Feedwater						
Condensate						
Makeup						

$$\%Makeup = \frac{Conductivity\_of\_Feedwater - Conductivity\_of\_Condensate}{Conductivity\_of\_MU - Conductivity\_of\_Condensate} * 100$$

$$\%Blowdown = \frac{Conductivity\_of\_Feedwater}{Conductivity\_of\_Boiler - Conductivity\_of\_Feedwater} * 100$$

Checklist for General Plant Safety & Reliability

Item	Present Y/N
Deaerator Tank Bypass.	
Condensate Tank Bypass.	
Softener Bypass.	
Auxiliary makeup to Deaerator.	
Emergency water to Boilers.	
High Oil Alarm on Oil Tanks.	
High Gas Pressure Cutout on Main Gas Line Coming into plant.	
Emergency Kill Switch (Oil and Gas) in Office and ALL Points of Egress.	

Sign In Sheet

PRINT **Name**	**VA Location**

SECTION 23 81 43
AIR-SOURCE UNITARY HEAT PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies electrically operated air-source unitary heat pumps.

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 is 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 is 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 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.

C. 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.

D. Section 23 23 00, REFRIGERANT PIPING: Requirements for field refrigerant piping.

E. Section 23 31 00, HVAC DUCTS AND CASINGS: Requirements for sheet metal ductwork.

F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and instrumentation.

G. Section 01 91 00 – GENERAL COMMISSIONING REQUIREMENTS

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.

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 and UL 1995.

D. Heating Performance shall conform to ASHRAE requirements when tested in accordance with AHRI and UL 1995.

E. Comply with requirements in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

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. Air-Source Unitary Heat pump:

   a. Split system

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 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

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 Specification (Fed. Spec.):

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:

AHRI-DCPP ....Directory of Certified Product Performance - Applied Directory of Certified Products

210/240-08................................Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment

270-08.......................................Sound Rating of Outdoor Unitary Equipment

310/380-04................................Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)

340/360-07................................Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

D. Air Movement and Control Association (AMCA):

210-07 .... Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)

410-96 .... Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans

E. American National Standards Institute (ANSI):

S12.51-02 (R2007) .... Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)

F. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc (ASHRAE):

15-10 .... Safety Standard for Refrigeration Systems (ANSI)

62.1-10 .... Ventilation for Acceptable Indoor Air Quality (ANSI)

90.1-07 .... Energy Standard for Buildings except Low-Rise Residential Buildings

2008 Handbook.......................... HVAC Systems and Equipment

G. American Society of Testing and Materials (ASTM):

B117-09..................................... Standard Practice for Operating Salt Spray (Fog) Apparatus

H. National Electrical Manufacturer's Association (NEMA):

MG 1-09 (R2010) .... Motors and Generators (ANSI)

ICS 1-00 (R2005)...................... Industrial Controls and Systems: General Requirements

I. National Fire Protection Association (NFPA):

90A-09....................................... Standard for the Installation of Air-Conditioning and Ventilating Systems

J. Underwriters Laboratory (UL):

1995-05 .... Heating and Cooling Equipment

PART II- PRODUCTS

2.1 UNITARY HEAT PUMPS, AIR TO AIR

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.

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.

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.

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: A minimum of two circuits is required. 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 adjustable idler-arm assembly for quick-adjustment of fan belts and 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).

J. Defrost Controls: 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 factory supplied DDC control system.
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, DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC 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 execut4ed 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, DIRECT DIGITAL CONTROL SYSTEM FOR HVAC for additional requirements.

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 heat pumps 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. 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 Project Engineer.

C. Furnish test reports to the Senior Project Engineer in accordance with specification Section 01 00 00, GENERAL REQUIREMENTS.

3.3 INSTRUCTIONS

Provide services of manufacturer’s technical representative for four hours to instruct VA personnel in operation and maintenance of heat pumps.

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 Project 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS 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 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

SECTION 26 05 11
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section supplements all sections of this Division and shall apply to all phases of work hereinafter specified, shown on the drawings, or required to provide a complete installation of electrical systems for the Project. The Work required under this Division, is not limited to the Electrical Drawings. Refer to Site, Architectural, Structural, Mechanical and other Drawings that may designate Work to be accomplished. The intent of the Specifications is to provide a complete electrical system that includes all documents that are a part of the Contract.

1. Work Included: Furnish all labor, material, services, and skilled supervision necessary for the construction, erection, installation, connections, testing, and adjustment of all circuits and electrical equipment specified herein, or shown or noted on the Drawings, and it’s delivery to VA complete in all respects ready for use.

B. Contract Drawings: The Contract Drawings are diagrammatic, and are intended to convey the Scope of Work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the Contract Drawings in laying out the work and verify the spaces for the installation of the materials and equipment based on actual dimensions of equipment furnished. Where conflicts occur, the most stringent condition shall apply. Wherever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Designer before proceeding with the Work.

C. Equipment or Fixtures: Equipment and fixtures shall be connected to provide circuit continuity in accordance with the Specifications, whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures, and the point of circuit origin.

D. Work Installed but Furnished under other sections: The Electrical Work includes the installation or connection of certain materials and equipment furnished under other sections. Verify installation details. Foundations for apparatus and equipment will be furnished under other sections unless otherwise noted or detailed.

E. Furnish and install electrical wiring, systems, equipment and accessories in accordance with the specification and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, generators and other items and arrangements for the specified items are shown on drawings.

F. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product which:
    a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
    b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
    c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:

1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.
2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
3. Components shall be compatible with each other and with the total assembly for the intended service.
4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:

1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Project Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
2. Four copies of certified test reports containing all test data shall be furnished to the Project Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.7 EQUIPMENT REQUIREMENTS

Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.

1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
3. Damaged equipment shall be, as determined by the Project Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:

1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.

3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Project Engineer and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Project Engineer.

D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

A. Equipment location shall be as close as practical to locations shown on the drawings.

B. Working spaces shall not be less than specified in the NEC for all voltages specified.

C. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers (starters), fused and unfused safety switches, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm^2), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.

1. Mark the submittals, "SUBMITTED UNDER SECTION__________________".
2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
3. Submit each section separately.

E. The submittals shall include the following:

1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and/or attached to the equipment.
3. Elementary and interconnection wiring diagrams for communication and signal systems, control systems and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.

4. Parts list which shall include those replacement parts recommended by the equipment manufacturer.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
   a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
   b. A control sequence describing start-up, operation, and shutdown.
   c. Description of the function of each principal item of equipment.
   d. Installation instructions.
   e. Safety precautions for operation and maintenance.
   f. Diagrams and illustrations.
   g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.
   h. Performance data.
   i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
   j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Project Engineer with one sample of each of the following:

1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
2. Each type of conduit coupling, bushing and termination fitting.
3. Conduit hangers, clamps and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 TESTING AND ADJUSTING

A. Upon completion of all Electrical Work, the contractor shall provide all testing as follows.
   1. Operational Test: Test all circuit breakers, receptacles and all other electrical equipment. Replace all faulty devices and equipment discovered during testing with new devices and equipment at no additional cost, and that part of the system (or devices or equipment) shall then be rested.
   2. Secondary Grounding Resistance: Perform ground continuity test between main ground system and equipment frame, system neutral and/or derived neutral point.
   3. Ground Fault System Test: Measure system neutral insulation resistances to ensure no shunt ground paths exist.
   4. All grounding resistance and ground fault test procedures shall be performed by an independent testing firm.

1.15 FINAL INSPECTION AND ACCEPTANCE CHECKS AND TESTS

A. After all requirements of the specifications and/or the drawings have been fully completed; representatives of VA will inspect the Work. The Contractor shall provide competent personnel to demonstrate the operation of any item of system, to the full satisfaction of each representative.
B. Provide manuals for attendees.
C. Final acceptance of the work will be made by VA after receipt of approval and recommendation of acceptance from each representative.
D. The Contractor shall furnish Record Drawings before final payment of retention.

1.16 WARRANTIES

A. Guarantee all materials, equipments, apparatus and workmanship to be free of defective material and faulty workmanship for period of one year unless extended guarantee periods are specified in individual sections.

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SECTION 26 05 21
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

1. Manufacturer's Literature and Data: Showing each cable type and rating.
2. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Project Engineer
    a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
    b. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):

D2301-04 ....Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Fire Protection Association (NFPA):

70-08 .... National Electrical Code (NEC)

D. National Electrical Manufacturers Association (NEMA):

WC 70-09 .... Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

E. Underwriters Laboratories, Inc. (UL):

44-05 .... Thermoset-Insulated Wires and Cables

83-08 .... Thermoplastic-Insulated Wires and Cables

467-071 .... Electrical Grounding and Bonding Equipment

486A-486B-03 .... Wire Connectors

486C-04 .... Splicing Wire Connectors

486D-05 .... Sealed Wire Connector Systems

486E-94...................................... Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-07 .... Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable

514B-04...................................... Conduit, Tubing, and Cable Fittings

1479-03 .... Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.

B. Single Conductor:

1. Shall be annealed copper.
2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.

C. Insulation:

1. XHHW-2 or THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.

D. Color Code:

1. Secondary service feeder and branch circuit conductors shall be color-coded as follows:

208/120 volt	Phase	480/277 volt
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

a. Lighting circuit “switch legs” and 3-way switch “traveling wires” shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the Project Engineer.

2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
   a. Solid color insulation or solid color coating.
   b. Stripes, bands, or hash marks of color specified above.
   c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

2.2 SPLICES AND JOINTS

A. In accordance with UL 486A, C, D, E, and NEC.

B. Aboveground Circuits (No. 10 AWG and smaller):
1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220˚ F [105˚ C], with integral insulation, approved for copper conductors.
2. The integral insulator shall have a skirt to completely cover the stripped wires.
3. The number, size, and combination of conductors, as listed on the manufacturer's packaging, shall be strictly followed.

C. Aboveground Circuits (No. 8 AWG and larger):
1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper.
2. Field-installed compression connectors for cable sizes 250 kcmil and larger shall have not fewer than two clamping elements or compression indents per wire.
3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.
4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

2.3 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified for power and lighting wiring, except that the minimum size shall be not less than No. 14 AWG.

B. Control wiring shall be large enough such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.4 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with the NEC, and as specified.

B. Install all wiring in raceway systems.

C. Splice cables and wires only in outlet boxes, junction boxes, pull-boxes, manholes, or handholes.

D. Wires of different systems (e.g., 120 V, 277 V) shall not be installed in the same conduit or junction box system.

E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.

F. For panel boards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.

G. Wire Pulling:

1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables. Use lubricants approved for the cable.
2. Use nonmetallic ropes for pulling feeders.
3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Project Engineer.
4. All cables in a single conduit shall be pulled simultaneously.
5. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

H. No more than three single-phase branch circuits shall be installed in any one conduit. Provide dedicated neutral conductor on each branch circuit, common neutral not allowed.

3.2 SPLICE INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure.

B. Tighten electrical connectors and terminals according to manufacturer's published torque values.

C. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.3 FEEDER IDENTIFICATION

A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

3.4 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

3.5 CONTROL AND SIGNAL WIRING INSTALLATION

A. Unless otherwise specified in other sections install wiring and connect to equipment/devices to perform the required functions as shown and specified.

B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

3.6 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION

A. Install a permanent wire marker on each wire at each termination.

B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

C. Wire markers shall retain their markings after cleaning.

3.7 ACCEPTANCE CHECKS AND TESTS

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be intercepted and to be reused shall also be tested.

B. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.

C. Perform phase rotation test on all three-phase circuits.

D. The contractor shall furnish the instruments, materials, and labor for all tests.

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the general grounding and bonding requirements for electrical equipment and operations to provide a low impedance path for possible ground fault currents.

B. “Grounding electrode system” refers to all electrodes required by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms “connect” and “bond” are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:

1. Clearly present enough information to determine compliance with drawings and specifications.
2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:

1. Certification that the materials and installation are in accordance with the drawings and specifications.
2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

A. American Society for Testing and Materials (ASTM):

B1-07..Standard Specification for Hard-Drawn Copper Wire

B3-07..Standard Specification for Soft or Annealed Copper Wire

B8-04..Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983 ....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C2-07..National Electrical Safety Code

C. National Fire Protection Association (NFPA):

70-08 ....National Electrical Code (NEC)

99-2005 ....Health Care Facilities

D. Underwriters Laboratories, Inc. (UL):

44-05 ....Thermoset-Insulated Wires and Cables

83-08 ....Thermoplastic-Insulated Wires and Cables

467-07 ....Grounding and Bonding Equipment

486A-486B-03 ....Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be ASTM B1 solid bare copper wire.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.2 GROUND RODS

A. Copper clad steel, 0.75 in [19 mm] diameter by 10 ft [3.048 M] long, conforming to UL 467.

B. Quantity of rods shall be as required to obtain the specified ground resistance, as shown on the drawings.

2.3 CONCRETE ENCASED ELECTRODE

Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
   1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
   2. Connection to Building Steel: Exothermic-welded type connectors.
   3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
   4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 0.375 in [4 mm] thick x 0.75 in [19 mm] wide.

2.6 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.

B. System Grounding:
   1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
   2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
   1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.

2. Provide a supplemental ground electrode and bond to the grounding electrode system.

C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.

3.4 RACEWAY

A. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
3. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.

D. Wireway Systems:

1. Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm^2] bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated No. 6 AWG [16 mm^2] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].
3. Use insulated No. 6 AWG [16 mm^2] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
4. Use insulated No. 6 AWG [16 mm^2] bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 49 ft [15 M].

E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.7 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications to the grounding system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.

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SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes, to form complete, coordinated, grounded raceway systems. Raceways are required for all wiring unless shown or specified otherwise.

B. Definitions: The term conduit, as used in this specification, shall mean any or all of the raceway types specified.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

A. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.

B. Shop Drawings:

1. Size and location of main feeders.
2. Size and location of panels and pull-boxes.

C. Certifications:

1. Two weeks prior to the final inspection, submit four copies of the following certifications to the Project Engineer:
    a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
    b. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American National Standards Institute (ANSI):

C80.1-05 ....Electrical Rigid Steel Conduit

C80.3-05 .... Steel Electrical Metal Tubing

C80.6-05 .... Electrical Intermediate Metal Conduit

C. National Fire Protection Association (NFPA):

70-08 .... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

1-05 .... Flexible Metal Conduit

5-04 .... Surface Metal Raceway and Fittings

6-07 .... Electrical Rigid Metal Conduit - Steel

50-95 .... Enclosures for Electrical Equipment

360-093 .... Liquid-Tight Flexible Steel Conduit

467-07 .... Grounding and Bonding Equipment

514A-04...................................... Metallic Outlet Boxes

514B-04...................................... Conduit, Tubing, and Cable Fittings

514C-96 .... Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers

651-05 .... Schedule 40 and 80 Rigid PVC Conduit and Fittings

651A-00...................................... Type EB and A Rigid PVC Conduit and HDPE Conduit

797-07 .... Electrical Metallic Tubing

1242-06 .... Electrical Intermediate Metal Conduit - Steel

E. National Electrical Manufacturers Association (NEMA):

TC-2-03 .... Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

TC-3-04 .... PVC Fittings for Use with Rigid PVC Conduit and Tubing

FB1-07 .... Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 0.5 inch [13 mm] unless otherwise shown. Where permitted by the NEC, 0.5 inch [13 mm] flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:

1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.
3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
4. Flexible galvanized steel conduit: Shall conform to UL 1.
5. Liquid-tight flexible metal conduit: Shall conform to UL 360.

C. Conduit Fittings:

1. Rigid steel and IMC conduit fittings:

a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2. Electrical metallic tubing fittings:
   a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
   d. Indent-type connectors or couplings are prohibited.
   e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible steel conduit fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp-type, with insulated throat.
4. Liquid-tight flexible metal conduit fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Expansion and deflection couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.

d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:

1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:

1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with UL, NEC, as shown, and as specified herein.

B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.

C. Install conduit as follows:

1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

5. Cut square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

D. Conduit Bends:
1. Make bends with standard conduit bending machines.
2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the Project Engineer.

3.3 CONCEALED WORK INSTALLATION

A. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors above 600 V: Rigid steel. Mixing different types of conduits indiscriminately in the same system is prohibited.
2. Conduit for conductors 600 V and below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
5. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors above 600 V: Rigid steel. Mixing different types of conduits indiscriminately in the system is prohibited.
C. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
D. Align and run conduit parallel or perpendicular to the building lines.
E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
F. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
G. Surface metal raceways: Use only where shown.
H. Painting:
    1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
    2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

3.5 WET OR DAMP LOCATIONS

A. Unless otherwise shown, use conduits of rigid steel or IMC.
B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
C. Unless otherwise shown, use rigid steel or IMC conduit within 5 ft [1.5 M] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

3.6 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.
B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

3.7 EXPANSION JOINTS

A. Conduits 3 inches [75 mm] and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.
B. Provide conduits smaller than 3 inches [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to

produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.

C. Install expansion and deflection couplings where shown.

3.8 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:

   1. Existing Construction:

      a. Steel expansion anchors not less than 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.

      b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].

      c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Bolts supported only by plaster or gypsum wallboard are not acceptable.

G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

J. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

K. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.9 BOX INSTALLATION

A. Boxes for Concealed Conduits:

   1. Flush-mounted.

   2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."

E. On all branch circuit junction box covers, identify the circuits with black marker.

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SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 26.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the electrical systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division 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 Electrical systems will be commissioned:

1. Normal Power Distribution Systems (Grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
2. Emergency Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).

3. Critical Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
4. Essential Equipment Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
5. Lighting Controls (Control system hardware and occupancy sensor interface.

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Project Engineer prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Project Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.4 TRAINING OF VA PERSONNEL

A. Training of the VA's operation and maintenance personnel is required in cooperation with the Project Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Project Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

----- END -----

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of wiring devices.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 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. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.

C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the Project Engineer: Technical data sheets and information for ordering replacement units.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. National Fire Protection Association (NFPA):

70 ....National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):

WD 1 ....General Color Requirements for Wiring Devices

WD 6 ....Wiring Devices – Dimensional Requirements

D. Underwriter's Laboratories, Inc. (UL):

5 ....Surface Metal Raceways and Fittings

20 ....General-Use Snap Switches

231 ....Power Outlets

467 ....Grounding and Bonding Equipment

498 ....Attachment Plugs and Receptacles

943 ....Ground-Fault Circuit-Interrupters

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.

1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.

B. Duplex Receptacles: Commercial-grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.

1. Bodies shall be ivory in color.
2. Duplex Receptacles on Emergency Circuit:
4. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit, commercial-grade, suitable for mounting in a standard outlet box.
   a. Ground fault interrupter shall be consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
   b. Ground Fault Interrupter Duplex Receptacles (not hospital-grade) shall be the same as ground fault interrupter hospital-grade receptacles except for the "hospital-grade" listing.
6. Duplex Receptacles (not hospital grade): Shall be the same as hospital grade duplex receptacles except for the "hospital grade" listing and as follows.

a. Bodies shall be brown phenolic compound supported by a plated steel mounting strap having plaster ears.

C. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.

2.2 TOGGLE SWITCHES

A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.

1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.
2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plasters ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
3. Ratings:
   a. 120 volt circuits: 20 amperes at 120-277 volts AC.
   b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2.4 WALL PLATES

A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.

B. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.

C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

D. In psychiatric areas, wall plates shall be 302 stainless steel, have tamperproof screws and beveled edges.

E. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.

F. Duplex Receptacles on Emergency Circuit:

1. Bodies shall be red in color. Wall plates shall be red with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

C. Outlet boxes for light and switches shall be mounted on the strike side of doors.

D. Provide barriers in multigang outlet boxes to separate systems of different voltages, Normal Power and Emergency Power systems, and in compliance with the NEC.

E. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.

F. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

G. Install wall switches 48 inches [1200mm] above floor, OFF position down.

H. Install convenience receptacles 18 inches [450mm] above floor, and 6 inches [152mm] above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.

I. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

J. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

K. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

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SECTION 26 29 11
MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

All motor starters and variable speed motor controllers, including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise), shall meet these specifications.

1.2 RELATED WORK

A. Other sections which specify motor driven equipment, except elevator motor controllers.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint for nonstructural components.

C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.

C. Manuals:

1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams and information for ordering replacement parts.
    a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.
    b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
    c. Elementary schematic diagrams shall be provided for clarity of operation.

2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the Project Engineer.

D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the Project Engineer:

1. Certification that the equipment has been properly installed, adjusted, and tested.
2. Certification by the manufacturer that medium voltage motor controller(s) conforms to the requirements of the drawings and specifications. This certification must be furnished to the Project Engineer prior to shipping the controller(s) to the job site.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):

519 ....Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

C37.90.1....................................Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

C. National Electrical Manufacturers Association (NEMA):

ICS 1 ....Industrial Control and Systems General Requirements

ICS 1.1 ....Safety Guidelines for the Application, Installation and Maintenance of Solid State Control

ICS 2 ....Industrial Control and Systems, Controllers, Contactors and Overload Relays Rated 600 Volts DC

ICS 6 ....Industrial Control and Systems Enclosures

ICS 7 ....Industrial Control and Systems Adjustable-Speed Drives

ICS 7.1 ....Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems

D. National Fire Protection Association (NFPA):

70 ....National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

508 ....Industrial Control Equipment

PART 2 - PRODUCTS

2.1 MOTOR STARTERS, GENERAL

A. Shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.

B. Shall have the following features:

1. Separately enclosed unless part of another assembly.

2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
3. Motor control circuits:
   a. Shall operate at not more than 120 volts.
   b. Shall be grounded except as follows:
      1) Where isolated control circuits are shown.
      2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
   c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
   d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
4. Overload current protective devices:
   a. Overload relay (thermal or induction type).
   b. Overload relay (solid state type).
   c. One for each pole.
   d. Manual reset on the door of each motor controller enclosure.
   e. Correctly sized for the associated motor's rated full load current.
   f. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
   g. Deliver four copies of a summarized list to the Project Engineer, which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.
5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.
6. Incorporate into each control circuit a 120-volt, solid state time delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time delay relay is not required where H-O-A switch is not required.
7. Unless noted otherwise, equip with not less than two normally open and two normally closed auxiliary contacts. Provide green run pilot lights and H-O-A control devices as indicated, operable at front of enclosure without opening enclosure. Push buttons, selector switches, pilot lights, etc., shall be interchangeable.
8. Enclosures:
   a. Shall be the NEMA types shown on the drawings for the motor controllers and shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.

b. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.

c. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.

C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.

D. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.

E. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete installation.

2.2 MANUAL MOTOR STARTERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Manual motor starters.

1. Starters shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
2. Units shall include overload and low voltage protection, red pilot light, NO and NC auxiliary contact and toggle operator.

C. Fractional horsepower manual motor starters.

1. Starters shall be general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload protection, red pilot light and toggle operator.

D. Motor starting switches.

1. Switches shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload protection, red pilot light low voltage protection, NO and NC auxiliary contact and toggle operator.

2.3 MAGNETIC MOTOR STARTERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Starters shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.

C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.

D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced voltage starters. Equip starters with 120V AC coils and individual control transformer unless otherwise noted. Locate "reset" button to be accessible without opening the enclosure.

2.4 REDUCED VOLTAGE MOTOR CONTROLLERS

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall be installed as shown for motors on the contract drawings.

C. Shall have closed circuit transition for the types which can incorporate such transition.

D. Shall limit inrush currents to not more than 70 percent of the locked rotor currents.

E. Provide phase loss protection for each starter, with contacts to de-

2.6 VARIABLE SPEED MOTOR CONTROLLERS

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.

C. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.

D. Operating and Design Conditions:

Elevation: 100 feet AMSL

Temperatures: Maximum +90ºF, Minimum -10ºF

Relative Humidity: 95%

Drive Location: Air conditioned Building

E. Controllers shall have the following features:

1. Isolated power for control circuits.
2. Manually re-settable motor overload protection for each phase.
3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
6. Automatic frequency adjustment from 20 Hz to 60 Hz.

7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The drive shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
   a. Incorrect phase sequence.
   b. Single phasing.
   c. Over voltage in excess of 10 percent.
   d. Under voltage in excess of 10 percent.
   e. Running over current above 110 percent (shall not automatically reset for this condition.)
   f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
   g. Surge voltage in excess of 1000 volts.
   h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Provide automatic shutdown on receipt of a power transfer warning signal from an automatic transfer switch. Controller shall automatically restart motor after the power transfer.
9. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
10. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
11. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.

G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.

H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.

I. Controller shall include a 3% line reactor, and RFI/EMI filter.

J. The following accessories are to be door mounted:
1. AC Power on light.
2. Ammeter (RMS motor current).
3. HAND-OFF-AUTOMATIC switch.
4. Manual speed control in HAND mode.

5. System protection lights indicating that the system has shutdown and will not automatically restart.
6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
7. Manual variable speed controller by-pass switch.
8. Diagnostic shutdown indicator lights for each shutdown condition.
9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
   a. System shutdown with auto restart.
   b. System shutdown without auto restart.
   c. System running.
10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519.

K. Hardware and software to enable the BAS to monitor, control, and display controller status and alarms.

L. Network Communications Ports: Ethernet and RS-422/485.

M. Embedded BAS Protocols for Network Communications: As specified in Division 22.

N. Bypass Operation: Manually transfers motor between power converter output and bypass circuit, manually, automatically, or both. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

O. Bypass Controller: Provide contactor-style bypass, arranged to isolate the power converter input and output and permit safe testing of the power converter, both energized and de-energized, while motor is operating in bypass mode. Motor overload protection shall be provided.
1. Bypass Contactor: Load-break NEMA-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2.7 MOTOR CONTROL STATIONS

A. Shall have the following features:

1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
   a. Red while the motor is running.
   b. Green while the motor is stopped.
4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.

B. Components of Motor Control Circuits:
1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.

B. In seismic areas, equipment shall be adequately anchored and braced per details on structural contract drawing to withstand the seismic forces at the location where installed.

C. Furnish and install heater elements in motor starters and to match the installed motor characteristics. Submit a list of all motors listing motor nameplate rating and heater element installed.

D. Motor Data: Provide neatly-typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating and heater element installed.

E. Connect hand-off auto selector switches so that automatic control only is by-passed in "manual" position and any safety controls are not by-passed.

F. Install manual motor starters in flush enclosures in finished areas.

G. Examine control diagrams indicated before ordering motor controllers. Should conflicting data exist in specifications, drawings and diagrams, request corrected data prior to placing orders.

3.2 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Project Engineer before increasing settings.

D. In reduced-voltage solid-state controllers, set field-adjustable switches and program microprocessors for required start and stop sequences.

3.3 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection
    a. Compare equipment nameplate data with specifications and approved shop drawings.
    b. Inspect physical, electrical, and mechanical condition.
    c. Inspect contactors.
    d. Clean motor starters and variable speed motor controllers.
    e. Verify overload element ratings are correct for their applications.
    f. If motor-running protection is provided by fuses, verify correct fuse rating.
    g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.
2. Variable speed motor controllers:
    a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
    b. Test all control and safety features of the variable frequency drive.

3.4 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

3.5 SPARE PARTS

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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SECTION 26 29 21
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of low voltage disconnect switches.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLTS AND BELOW: Cables and wiring.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.

D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:

1. Clearly present sufficient information to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.

C. Manuals:

1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the Project Engineer two weeks prior to final inspection.
2. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.
3. Wiring diagrams shall indicate internal wiring and any interlocking.

D. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Project Engineer:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.

2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) 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):

FU l-07 .... Low Voltage Cartridge Fuses

KS l-06 .... Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

C. National Fire Protection Association (NFPA):

70-08 .... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

98-04 .... Enclosed and Dead-Front Switches

248-00 .... Low Voltage Fuses

977-94 .... Fused Power-Circuit Devices

PART 2 - PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

A. In accordance with UL 98, NEMA KS1, and NEC.

B. Shall have NEMA classification General Duty (GD) for 240 V switches and NEMA classification Heavy Duty (HD) for 480 V switches.

C. Shall be HP rated.

D. Shall have the following features:

1. Switch mechanism shall be the quick-make, quick-break type.
2. Copper blades, visible in the OFF position.
3. An arc chute for each pole.
4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
6. Fuse holders for the sizes and types of fuses specified.
7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
8. Ground lugs for each ground conductor.
9. Enclosures:
   a. Shall be the NEMA types shown on the drawings for the switches.

b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.

c. Shall be finished with manufacturer’s standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but without provisions for fuses.

2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, except for the minimum duty rating which shall be NEMA classification Heavy Duty (HD). These switches shall also be HP rated.

2.4 LOW VOLTAGE CARTRIDGE FUSES

A. In accordance with NEMA FU1.

B. Feeders: Class L, fast acting, Class RK1 , fast acting, Class RK5, fast acting, Class J, fast acting.

C. Motor Branch Circuits: Class RK1 or Class RK5, time delay.

D. Other Branch Circuits: Class RK1, time delay.

E. Control Circuits: Class CC, fast acting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches in accordance with the NEC and as shown on the drawings.

B. Fusible disconnect switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuse.

3.2 SPARE PARTS

Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fusible disconnect switch installed on the project. Deliver the spare fuses to the Project Engineer.

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SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of the interior lighting systems.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural Components.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

E. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.

1. Material and construction details include information on housing, optics system and lens/diffuser.
2. Physical dimensions and description.
3. Wiring schematic and connection diagram.
4. Installation details.
5. Energy efficiency data.
6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).

C. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Project Engineer.

D. Certifications:

1. Two weeks prior to final inspection, submit four copies of the following certifications to the Project Engineer:
   a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):

C62.41-91 .... Guide on the Surge Environment in Low Voltage (1000V and less) AC Power Circuits

C. National Fire Protection Association (NFPA):

70 .... National Electrical Code (NEC)

101 .... Life Safety Code

D. National Electrical Manufacturer's Association (NEMA):

C82.1-97 .... Ballasts for Fluorescent Lamps - Specifications

C82.2-02 .... Method of Measurement of Fluorescent Lamp Ballasts

C82.11-02 .... High Frequency Fluorescent Lamp Ballasts

E. Underwriters Laboratories, Inc. (UL):

496-96 .... Edison-Base Lampholders

542-99 .... Lampholders, Starters, and Starter Holders for Fluorescent Lamps

844-95 .... Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

924-95 .... Emergency Lighting and Power Equipment

935-01 .... Fluorescent-Lamp Ballasts

1598-00 .... Luminaires

8750-08................Light Emitting Diode (LED) Light Sources for Use in Lighting Products

F. Federal Communications Commission (FCC):

Code of Federal Regulations (CFR), Title 47, Part 18

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES (LUMINAIRES)

A. Shall be in accordance with NFPA 70 and UL 1598, as shown on drawings, and as specified.

B. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.
2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
3. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, latches shall function easily by finger action without the use of tools.

C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

D. Lamp Sockets:

1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Lamp holders for bi-pin lamps shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.

E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

G. Metal Finishes:

1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
3. Exterior finishes shall be as shown on the drawings.

H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

I. Light Transmitting Components for Fluorescent Fixtures:

1. Shall be 100 percent virgin acrylic.

2. Flat lens panels shall have not less than 1/8 inch [3.2mm] of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.

J. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures (not the lamp). Fixtures shall be designed for lamps as specified.

2.2 BALLASTS

A. Linear Fluorescent Lamp Ballasts: 120V rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:

1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: 10 percent or less.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. Ballast Factor: 0.87 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.
12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.

B. Compact Fluorescent Lamp Ballasts: 120V electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: 10 percent or less.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. Ballast Factor: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.

C. Ballasts for high intensity discharge fixtures: Multi-tap voltage (120- 480v) electromagnetic ballast for high intensity discharge lamps. Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.3 LAMPS

A. Linear T5 and T8 Fluorescent Lamps:

1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature between 3500° and 4100°K, a Color Rendering Index (CRI) of greater than 70, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.
   a. Over the beds in Intensive Care, Coronary Care, Recovery, Life Support, and Observation and Treatment areas; Electromyographic, Autopsy (Necropsy), Surgery, and

certain dental rooms (Examination, Oral Hygiene, Oral Surgery, Recovery, Labs, Treatment, and X-Ray) use color corrected lamps having a CRI of 85 or above and a correlated color temperature between 5000 and 6000°K.

b. Other areas as indicated on the drawings.

B. Compact Fluorescent Lamps:

1. T4, CRI 80 (minimum), color temperature 3500 K, and suitable for use with dimming ballasts, unless otherwise indicated.

C. Long Twin-Tube Fluorescent Lamps:

1. T5, CRI 80 (minimum), color temperature between 3500° and 4100°K, 20,000 hours average rated life.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, manufacturer's instructions and as shown on the drawings or specified.

B. Align, mount and level the lighting fixtures uniformly.

C. Fluorescent bed light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable.

D. Lighting Fixture Supports:

1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.

2. Shall maintain the fixture positions after cleaning and relamping.

3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.

4. Hardware for recessed lighting fixtures:

a. All fixture mounting devices connecting fixtures to the ceiling system or building structure shall have a capacity for a horizontal force of 100 percent of the fixture weight and a vertical force of 400 percent of the fixture weight.

b. Mounting devices shall clamp the fixture to the ceiling system structure (main grid runners or fixture framing cross runners) at four points in such a manner as to resist spreading of these supporting members. Each support point device shall utilize a screw or approved hardware to "lock" the fixture housing to the ceiling system, restraining the fixture from movement in any direction relative to the ceiling. The screw (size No. 10 minimum) or approved hardware shall pass through the ceiling member (T-bar, channel or spline), or it may extend over the inside of the flange of the channel (or spline) that faces away from the fixture, in a manner that prevents any fixture movement.

c. In addition to the above, the following is required for fixtures exceeding 20 pounds [9kg] in weight.

1) Where fixtures mounted in ASTM Standard C635-69 "Intermediate" and "Heavy Duty" ceilings and weigh between 20 pounds and 56 pounds [9kg and 25kg] provide two 12 gauge safety hangers hung slack between diagonal corners of the fixture and the building structure.

2) Where fixtures weigh over 56 pounds [25kg] they shall be independently supported from the building structure by approved hangers. Two-way angular bracing of hangers shall be provided to prevent lateral motion.

d. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.

5. Surface mounted lighting fixtures:

a. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.

6. Single or double pendant-mounted lighting fixtures:

a. Each stem shall be supported by an approved outlet box, mounted swivel joint and canopy which holds the stem captive and provides spring load (or approved equivalent) dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.

7. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.

E. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.

F. Coordinate between the electrical and ceiling trades to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

G. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

H. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.

I. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.

J. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

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