

# Construction Document Submittal

Prepared for:

Department of Veterans Affairs  
Medical Center  
4100 West Third Street  
Dayton, OH 45428

## Improve Building Automation System

VA Project Number 552-15-207  
Heapy Engineering No. 2013-04011

Prepared by:



**Date: May 23, 2014**

**DEPARTMENT OF VETERANS AFFAIRS  
VHA MASTER SPECIFICATIONS**

**TABLE OF CONTENTS  
Section 00 01 10**

	<b>DIVISION 00 - SPECIAL SECTIONS</b>	<b>DATE</b>
00 01 15	List of Drawing Sheets	09-11
	<b>DIVISION 01 - GENERAL REQUIREMENTS</b>	
01 00 00	General Requirements	10-13
01 32 16.15	Project Schedules	04-13
01 33 23	Shop Drawings, Product Data, and Samples	11-08
01 42 19	Reference Standards	09-11
	<b>DIVISION 02 – EXISTING CONDITIONS</b>	
02 41 00	Demolition	04-13
	<b>DIVISION 07 - THERMAL AND MOISTURE PROTECTION</b>	
07 84 00	Firestopping	10-11
07 92 00	Joint Sealants	12-11
	<b>DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)</b>	
23 05 11	Common Work Results for HVAC	11-10
23 08 11	Demonstrations and Tests for Boiler Plant	11-10
23 09 11	Instrumentation and Control for Boiler Plant	11-10
23 09 23	Direct-Digital Control System for HVAC	09-11
23 15 00	General Service Compressed Air Systems	12-09
	<b>DIVISION 26 – ELECTRICAL</b>	
26 05 11	Requirements for Electrical Installations	12-12
26 05 19	Low-Voltage Electrical Power Conductors and Cables	07-13
26 05 26	Grounding and Bonding for Electrical Systems	12-12
26 05 33	Raceway and Boxes for Electrical Systems	09-10
	<b>DIVISION 27 – COMMUNICATIONS</b>	
27 05 11	Requirements for Communications Installations	11-09
27 10 00	Structured Cabling	12-05
27 11 00	Communications Equipment Room Fittings	06-13
27 15 00	Communications Horizontal Cabling	06-13

**SECTION 00 01 15**  
**LIST OF DRAWING SHEETS**

The drawings listed below accompanying this specification form a part of the contract.

Drawing No.

Title

**GENERAL**

C001

COVER SHEET

**HEATING, VENTILATING, AIR CONDITIONING**

M001

LEGEND, ABBREVIATIONS, AND GENERAL NOTES

MS

SITE PLAN

MF126

BUILDING 126 FLOOR PLANS

MC126

BUILDING 126 CONTROLS AND AUTOMATION

MF147

BUILDING 147 FLOOR PLANS

MF307

BUILDING 307 FLOOR PLANS

MC307A

BUILDING 307 CONTROLS AND AUTOMATION

MC307B

BUILDING 307 CONTROLS AND AUTOMATION

MC307C

BUILDING 307 CONTROLS AND AUTOMATION

M310

BUILDING 310 FLOOR PLANS, CONTROLS AND  
AUTOMATION

MC310

BUILDING 310 CONTROLS AND AUTOMATION

M320

BUILDING 320 FLOOR PLANS, CONTROLS AND  
AUTOMATION

M330

BUILDING 330 FLOOR PLANS, CONTROLS AND  
AUTOMATION

--- END ---

**SECTION 01 00 00  
GENERAL REQUIREMENTS**

**TABLE OF CONTENTS**

1.1 GENERAL INTENTION.....	1
1.2 STATEMENT OF BID ITEM(S) .....	2
1.3 construction security requirements.....	2
1.4 FIRE SAFETY .....	4
1.5 OPERATIONS AND STORAGE AREAS.....	6
1.6 ALTERATIONS.....	10
1.7 INFECTION PREVENTION MEASURES.....	11
1.8 DISPOSAL AND RETENTION .....	13
1.9 RESTORATION.....	13
1.10 TEMPORARY USE OF EXISTING ELEVATORS .....	14
1.11 TEMPORARY TOILETS .....	15
1.12 AVAILABILITY AND USE OF UTILITY SERVICES .....	15
1.13 TESTS.....	16
1.14 INSTRUCTIONS.....	17
1.15 GOVERNMENT-FURNISHED PROPERTY .....	17
1.16 photographic documentation .....	18

**SECTION 01 00 00  
GENERAL REQUIREMENTS**

**1.1 GENERAL INTENTION**

- A. Contractor shall completely prepare site for building operations, including demolition and removal of existing structures, and furnish labor and materials and perform work for "Improve Building Automation System" as required by drawings and specifications.
- B. Medical Center Engineering Officer will schedule a pre-bid site walk-through for all contractors wishing to see the site. No other access will be permitted.
- C. Offices of Heapy Engineering, 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 COR 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 COR.
- E. All employees of general contractor and subcontractors 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 designated "competent person" (CP) (29 CFR 1926.20(b)(2)) will maintain a presence at the work site whenever the general or subcontractors are present.
- G. Training:
  - 1. All employees of general contractor or subcontractors shall have the 10-hour or 30-hour OSHA Construction Safety course and other relevant competency training, as determined by COR acting as the Construction Safety Officer with input from the facility Construction Safety Committee.
  - 2. Submit training records of all such employees for approval before the start of work.
- H. VHA Directive 2011-36, Safety and Health during Construction, dated 9/22/2011 in its entirety is made a part of this section.

- I. VA will evaluate and consider past safety records of prospective contractors in awarding contracts. At a minimum, Contractors must not have more than three serious, or one repeat, or one willful OSHA violation(s) in the past 3 years, or any significant environmental penalties. Additionally, Contractors must have an Experience Modification Rate (EMR) of equal to or less than 1.0 (EMR of 1.0 indicates that a Contractor had an average insurance claim's rate for worker injuries).

## **1.2 STATEMENT OF BID ITEM(S)**

- A. BID ITEM #1: BASE BID ALL WORK: work shall include all labor, material, equipment and supervision required to complete project "Improve Building Automation System" at the Department of Veterans Affairs Medical Center, 4100 West Third Street, Dayton, Ohio 45428. Work includes general construction, alterations, mechanical and electrical work, demolition and certain other items shown and specified. All phases of work shall be complete within 365 calendar days after receipt of Notice to Proceed.
- B. BID ITEM #2: DEDUCT ALTERNATE NO. 1: All work in BID ITEM #1, BASE BID except DELETE all labor and materials associated with providing one future copy of Tridium software updates. Updating of all existing Tridium software on campus under this contract shall still occur.
- C. BID ITEM #3: DEDUCT ALTERNATE NO. 2: All work in BID ITEM #1, BASE BID except DELETE all work as specified in DEDUCT ALTERNATE #1 and DELETE all labor and materials associated with all scope of work in Building 307.

## **1.3 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.
  3. Contractor is responsible for all safety signage.
- B. Security Procedures:
  1. General Contractor's employees shall not enter the project site without appropriate identification badge, issued by the VA at the campus police station. VA Form 0711 shall be completed for each construction worker, with associated background check performed, prior to this badge being issued. Contractor employees 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 (outside area of construction) 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.

D. Key Control:

1. Contractor is responsible for securing their construction site. For interior projects, this means a full height barricade to the deck, where required and appropriate.
2. The General Contractor shall provide duplicate keys and lock combinations to the COR for the purpose of security inspections of every area of project including tool boxes and parked machines and take any emergency action.

E. 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.
3. 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.
4. These security documents shall not be removed or transmitted from the project site without the written approval of Contracting Officer.
5. All paper waste or electronic media such as CD’s and diskettes shall be shredded and destroyed in a manner acceptable to the VA.

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

**F. 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. There will be no parking allowed by any Contractors on Cincinnati VA campus.

**1.4 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):  
E84-2009 ..... Surface Burning Characteristics of Building Materials
2. National Fire Protection Association (NFPA):  
10-2010..... Standard for Portable Fire Extinguishers  
30-2008..... Flammable and Combustible Liquids Code  
51B-2009 ..... Standard for Fire Prevention During Welding, Cutting and Other Hot Work  
70-2011..... National Electrical Code  
101-2012..... Life Safety Code  
241-2009..... Standard for Safeguarding Construction, Alteration, and Demolition Operations



3. Occupational Safety and Health Administration (OSHA):

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

4. VHA Directive 2005-007

- 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 COR and Facility Safety Officer for review for compliance with VHA Directive 2005-007, NFPA 101 and NFPA 241. Prior to beginning work, all employees of the contractor and/or any subcontractors 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. Provide documentation to the COR that all construction workers 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).
- E. Temporary Construction Partitions:
1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and/or the areas that are described in phasing requirements and adjoining areas. Construct partitions of flame-retardant plastic sheeting (flame spread rating of 25 or less in accordance with ASTM E84). Extend the partitions from suspended ceilings to floor slab deck. Seal joints and penetrations.
  2. 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 241 and NFPA 70.
- G. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with COR and facility Safety Officer.

- H. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to COR 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 241 and NFPA 10.
- J. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.
- K. 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 COR 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 COR.
- L. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with COR and facility Safety Officer .
- M. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COR. Obtain permits from facility Safety Officer at least 72 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work.
- N. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to COR and facility Safety Officer.
- O. Smoking: Smoking is prohibited on the VA campus except in designated smoking rest areas.
- P. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.
- Q. Perform other construction, alteration and demolition operations in accordance with 29 CFR 1926.
- R. If required, submit documentation to the COR that personnel have been trained in the fire safety aspects of working in areas with impaired structural or compartmentalization features.

## **1.5 OPERATIONS AND STORAGE AREAS**

- A. Contractor shall provide storage for all materials and equipment. The Contractor shall confine all operations (including storage of materials) on Government premises only if 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.

**(FAR 52.236-10)**

- D. Working space and space available for storing materials shall be as determined by the COR.
- E. Workmen are subject to rules of Medical Center applicable to their conduct.
- 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. Use of equipment and tools that transmit vibrations and noises through the building structure, are not permitted in buildings that are occupied, during construction, jointly by patients or medical personnel, and Contractor's personnel, except as permitted by COR where required by limited working space.
  - 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 COR 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 COR two weeks in advance of the proposed date of starting work in each specific area of site, building or portion thereof. Arrange such dates to insure accomplishment of this work in successive phases mutually agreeable COR, as follows:
1. 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. The majority of immediate areas of alterations will be temporarily vacated while alterations are performed.
  3. Refer to drawings for additional project phasing requirements.
- H. When a building is turned over to Contractor, Contractor shall accept entire responsibility therefore.
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.
- I. 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 COR.

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 COR. 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.
  2. Contractor shall submit a request to interrupt any such services to COR, in writing, 48 hours in advance of proposed interruption. Request shall state reason, date, exact time of, and 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 21 calendar days prior to the desired time and shall be performed as directed by the COR.
  5. In case of a contract construction emergency, service will be interrupted on approval of COR. Such approval will be confirmed in writing as soon as practical.
- J. 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.
- K. 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.
- L. Coordinate the work for this contract with other construction operations as directed by COR. This includes the scheduling of traffic and the use of roadways, as specified in Article, USE OF ROADWAYS.

## 1.6 ALTERATIONS

- A. Survey: Before any work is started, the Contractor shall make a thorough survey with the COR 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, venetian blinds, shades, 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 COR.
- 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 COR, 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 COR 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 workmen in executing work of this contract.
- D. Protection: Provide the following protective measures:
  - 1. 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.

2. 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.

## **1.7 INFECTION PREVENTION MEASURES**

- A. Implement the requirements of VAMC's Construction Health and Safety Team (CHST). CHST 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 CHST Group as specified here. Prior to start of work, prepare a plan detailing project-specific dust protection measures, including periodic status reports, and submit to COR and Facility CHST team 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 COR 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 COR. 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 COR. For construction in any areas that will remain jointly occupied by the medical Center and Contractor's workers, the Contractor shall:
  - a. Provide a fire retardant polystyrene, 6-mil thick or greater plastic barrier meeting local fire codes.
  - b. Use of negative pressure machines with HEPA filtration is required throughout entire construction process. 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 600mm x 900mm (24" x 36"), 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 COR 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.

### 1.8 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 COR.
  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.

### 1.9 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 COR. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to the COR 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. Contractor shall utilize correct fire rated material for wall patches in rated walls.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen 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).

#### **1.10 TEMPORARY USE OF EXISTING ELEVATORS**

- A. Use of existing elevators for handling building materials and Contractor's personnel will be permitted subject to following provisions:
  - 1. Contractor makes all arrangements with the COR for use of elevators. The COR will ascertain that elevators are in proper condition. Contractor may use elevators Nos. P-5 & P-6 in Building No. 1 for special nonrecurring time intervals when permission is granted. Personnel for operating elevators will not be provided by the Department of Veterans Affairs.
  - 2. Contractor covers and provides maximum protection of following elevator components:
    - a. Entrance jambs, heads soffits and threshold plates.
    - b. Entrance columns, canopy, return panels and inside surfaces of car enclosure walls.
    - c. Finish flooring.
  - 3. Government will accept hoisting ropes of elevator and rope of each speed governor if they are worn under normal operation. However, if these ropes are damaged by action of foreign matter such as sand, lime, grit, stones, etc., during temporary use, they shall be removed and replaced by new hoisting ropes.

### **1.11 TEMPORARY TOILETS**

- A. Contractor may have for use of Contractor's workmen, such toilet accommodations as may be assigned to Contractor by Medical Center. Contractor shall keep such places clean and be responsible for any damage done thereto by Contractor's workmen. Failure to maintain satisfactory condition in toilets will deprive Contractor of the privilege to use such toilets.

### **1.12 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 COR'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 COR's discretion), of use of steam from the Medical Center's system.

### 1.13 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.

#### **1.14 INSTRUCTIONS**

- A. Contractor shall furnish Maintenance and Operating manuals (hard copies and electronic) and verbal instructions when required by the various sections of the specifications and as hereinafter specified.
- B. Manuals: Maintenance and operating manuals and one compact disc (four hard copies and one electronic copy each) for each separate piece of equipment shall be delivered to the COR 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 COR and shall be considered concluded only when the COR 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 COR, does not demonstrate sufficient qualifications in accordance with requirements for instructors above.

#### **1.15 GOVERNMENT-FURNISHED PROPERTY**

- A. The Government shall deliver to the Contractor, the Government-furnished property shown on the drawings.

- B. Equipment furnished by Government to be installed by Contractor will be furnished to Contractor at the Medical Center.
- C. Storage space for equipment shall be provided by the Contractor and the Contractor shall be prepared to unload and store such equipment therein upon its receipt at the Medical Center.
- D. Notify Contracting Officer in writing, 60 days in advance, of date on which Contractor will be prepared to receive equipment furnished by Government. Arrangements will then be made by the Government for delivery of equipment.
  - 1. Immediately upon delivery of equipment, Contractor shall arrange for a joint inspection thereof with a representative of the Government. At such time the Contractor shall acknowledge receipt of equipment described, make notations, and immediately furnish the Government representative with a written statement as to its condition or shortages.
  - 2. Contractor thereafter is responsible for such equipment until such time as acceptance of contract work is made by the Government.
- E. Equipment furnished by the Government will be delivered in a partially assembled (knock down) condition in accordance with existing standard commercial practices, complete with all fittings, fastenings, and appliances necessary for connections to respective services installed under contract. All fittings and appliances (i.e., couplings, ells, tees, nipples, piping, conduits, cables, and the like) necessary to make the connection between the Government furnished equipment item and the utility stub-up shall be furnished and installed by the contractor at no additional cost to the Government.
- F. Completely assemble and install the Government furnished equipment in place ready for proper operation in accordance with specifications and drawings.
- G. Furnish supervision of installation of equipment at construction site by qualified factory trained technicians regularly employed by the equipment manufacturer.

#### **1.16 PHOTOGRAPHIC DOCUMENTATION**

- A. During the construction period through completion, provide photographic documentation of construction progress on a daily basis. Pictures taken with cellular phone and emailed to COR is acceptable.

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**SECTION 01 32 16.15  
PROJECT SCHEDULES**

**PART 1- GENERAL**

**1.1 DESCRIPTION:**

- A. The Contractor shall develop a Critical Path Method (CPM) plan and schedule demonstrating fulfillment of the contract requirements (Project Schedule), and shall keep the Project Schedule up-to-date in accordance with the requirements of this section and shall utilize the plan for scheduling, coordinating and monitoring work under this contract (including all activities of subcontractors, equipment vendors and suppliers). Conventional Critical Path Method (CPM) technique shall be utilized to satisfy both time and cost applications.

**1.2 CONTRACTOR'S REPRESENTATIVE:**

- A. The Contractor shall designate an authorized representative responsible for the Project Schedule including preparation, review and progress reporting with and to the Contracting Officer's Representative.
- B. The Contractor's representative shall have direct project control and complete authority to act on behalf of the Contractor in fulfilling the requirements of this specification section.
- C. The Contractor's representative shall have the option of developing the project schedule within their organization or to engage the services of an outside consultant. If an outside scheduling consultant is utilized, Section 1.3 of this specification will apply.

**1.3 CONTRACTOR'S CONSULTANT:**

- A. The Contractor shall submit a qualification proposal to the COR, within 10 days of bid acceptance. The qualification proposal shall include:
  - 1. The name and address of the proposed consultant.
  - 2. Information to show that the proposed consultant has the qualifications to meet the requirements specified in the preceding paragraph.
  - 3. A representative sample of prior construction projects, which the proposed consultant has performed complete project scheduling services. These representative samples shall be of similar size and scope.
- B. The Contracting Officer has the right to approve or disapprove the proposed consultant, and will notify the Contractor of the VA decision within seven calendar days from receipt of the qualification proposal. In case of disapproval, the Contractor shall resubmit another consultant within 10 calendar days for renewed consideration. The Contractor shall have their scheduling consultant approved prior to submitting any schedule for approval.

**1.4 COMPUTER PRODUCED SCHEDULES**

- A. The contractor shall provide monthly, to the Department of Veterans Affairs (VA), all computer-produced time/cost schedules and reports generated from monthly project updates. This monthly

computer service will include: three copies of up to five different reports (inclusive of all pages) available within the user defined reports of the scheduling software approved by the Contracting Officer; a hard copy listing of all project schedule changes, and associated data, made at the update and an electronic file of this data; and the resulting monthly updated schedule in PDM format. These must be submitted with and substantively support the contractor's monthly payment request and the signed look ahead report. The COR shall identify the five different report formats that the contractor shall provide.

- B. The contractor shall be responsible for the correctness and timeliness of the computer-produced reports. The Contractor shall also responsible for the accurate and timely submittal of the updated project schedule and all CPM data necessary to produce the computer reports and payment request that is specified.
- C. The VA will report errors in computer-produced reports to the Contractor's representative within ten calendar days from receipt of reports. The Contractor shall reprocess the computer-produced reports and associated diskette(s), when requested by the Contracting Officer's representative, to correct errors which affect the payment and schedule for the project.

#### **1.5 THE COMPLETE PROJECT SCHEDULE SUBMITTAL**

- A. Within 45 calendar days after receipt of Notice to Proceed, the Contractor shall submit for the Contracting Officer's review; three blue line copies of the interim schedule on sheets of paper 765 x 1070 mm (30 x 42 inches) and an electronic file in the previously approved CPM schedule program. The submittal shall also include three copies of a computer-produced activity/event ID schedule showing project duration; phase completion dates; and other data, including event cost. Each activity/event on the computer-produced schedule shall contain as a minimum, but not limited to, activity/event ID, activity/event description, duration, budget amount, early start date, early finish date, late start date, late finish date and total float. Work activity/event relationships shall be restricted to finish-to-start or start-to-start without lead or lag constraints. Activity/event date constraints, not required by the contract, will not be accepted unless submitted to and approved by the Contracting Officer. The contractor shall make a separate written detailed request to the Contracting Officer identifying these date constraints and secure the Contracting Officer's written approval before incorporating them into the network diagram. The Contracting Officer's separate approval of the Project Schedule shall not excuse the contractor of this requirement. Logic events (non-work) will be permitted where necessary to reflect proper logic among work events, but must have zero duration. The complete working schedule shall reflect the Contractor's approach to scheduling the complete project. **The final Project Schedule in its original form shall contain no contract changes or delays which may have been incurred during the final network diagram development period and shall reflect the entire contract duration as defined in the bid documents.** These changes/delays shall be entered at the first update after the final Project Schedule has been approved. The Contractor should provide their



requests for time and supporting time extension analysis for contract time as a result of contract changes/delays, after this update, and in accordance with Article, ADJUSTMENT OF CONTRACT COMPLETION.

- B. Within 30 calendar days after receipt of the complete project interim Project Schedule and the complete final Project Schedule, the Contracting Officer or his representative, will do one or both of the following:
  - 1. Notify the Contractor concerning his actions, opinions, and objections.
  - 2. A meeting with the Contractor at or near the job site for joint review, correction or adjustment of the proposed plan will be scheduled if required. Within 14 calendar days after the joint review, the Contractor shall revise and shall submit three blue line copies of the revised Project Schedule, three copies of the revised computer-produced activity/event ID schedule and a revised electronic file as specified by the Contracting Officer. The revised submission will be reviewed by the Contracting Officer and, if found to be as previously agreed upon, will be approved.
- C. The approved baseline schedule and the computer-produced schedule(s) generated there from shall constitute the approved baseline schedule until subsequently revised in accordance with the requirements of this section.
- D. The Complete Project Schedule shall contain a detailed description of all work activities/events required to complete each project phase. This shall include such items as erection of temporary partitions, set up, shutdown/isolation/drainage of existing utility systems, asbestos abatement, demolition, new piping work, new sheetmetal work, reinsulation, power wiring, controls installation & wiring, testing adjusting and balancing, system/equipment startup, testing, Commissioning, clean up, etc.

#### **1.6 WORK ACTIVITY/EVENT COST DATA**

- A. The Contractor shall cost load all work activities/events except procurement activities. The cumulative amount of all cost loaded work activities/events (including alternates) shall equal the total contract price. Prorate overhead, profit and general conditions on all work activities/events for the entire project length. The contractor shall generate from this information cash flow curves indicating graphically the total percentage of work activity/event dollar value scheduled to be in place on early finish, late finish. These cash flow curves will be used by the Contracting Officer to assist him in determining approval or disapproval of the cost loading. Negative work activity/event cost data will not be acceptable, except on VA issued contract changes.
- B. The Contractor shall cost load work activities/events for guarantee period services, test, balance and adjust various systems in accordance with the provisions in Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.236 – 83 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS).

- C. In accordance with FAR 52.236 – 1 (PERFORMANCE OF WORK BY THE CONTRACTOR) and VAAR 852.236 – 72 (PERFORMANCE OF WORK BY THE CONTRACTOR), the Contractor shall submit, simultaneously with the cost per work activity/event of the construction schedule required by this Section, a responsibility code for all activities/events of the project for which the Contractor's forces will perform the work.
- D. The Contractor shall cost load work activities/events for all BID ITEMS including ASBESTOS ABATEMENT. The sum of each BID ITEM work shall equal the value of the bid item in the Contractors' bid.

#### **1.7 PROJECT SCHEDULE REQUIREMENTS**

- A. Show on the project schedule the sequence of work activities/events required for complete performance of all items of work. The Contractor Shall:
  - 1. Show activities/events as:
    - a. Contractor's time required for submittal of shop drawings, templates, fabrication, delivery and similar pre-construction work.
    - b. Contracting Officer's and Architect-Engineer's review and approval of shop drawings, equipment schedules, samples, template, or similar items.
    - c. Interruption of VA Facilities utilities, delivery of Government furnished equipment, and rough-in drawings, project phasing and any other specification requirements.
    - d. Test, balance and adjust various systems and pieces of equipment, maintenance and operation manuals, instructions and preventive maintenance tasks.
    - e. VA inspection and acceptance activity/event with a minimum duration of five work days at the end of each phase and immediately preceding any VA move activity/event required by the contract phasing for that phase.
  - 2. Show not only the activities/events for actual construction work for each trade category of the project, but also trade relationships to indicate the movement of trades from one area, floor, or building, to another area, floor, or building, for at least five trades who are performing major work under this contract.
  - 3. Break up the work into activities/events of a duration no longer than 20 work days each or one reporting period, except as to non-construction activities/events (i.e., procurement of materials, delivery of equipment, concrete and asphalt curing) and any other activities/events for which the COR may approve the showing of a longer duration. The duration for VA approval of any required submittal, shop drawing, or other submittals will not be less than 20 work days.
  - 4. Describe work activities/events clearly, so the work is readily identifiable for assessment of completion. Activities/events labeled "start," "continue," or "completion," are not specific and will not be allowed. Lead and lag time activities will not be acceptable.

5. The schedule shall be generally numbered in such a way to reflect either discipline, phase or location of the work.
- B. The Contractor shall submit the following supporting data in addition to the project schedule:
  1. The appropriate project calendar including working days and holidays.
  2. The planned number of shifts per day.
  3. The number of hours per shift.Failure of the Contractor to include this data shall delay the review of the submittal until the Contracting Officer is in receipt of the missing data.
- C. To the extent that the Project Schedule or any revised Project Schedule shows anything not jointly agreed upon, it shall not be deemed to have been approved by the COR. Failure to include any element of work required for the performance of this contract shall not excuse the Contractor from completing all work required within any applicable completion date of each phase regardless of the COR's approval of the Project Schedule.
- D. Compact Disk Requirements and CPM Activity/Event Record Specifications: Submit to the VA an electronic file(s) containing one file of the data required to produce a schedule, reflecting all the activities/events of the complete project schedule being submitted.

#### **1.8 PAYMENT TO THE CONTRACTOR:**

- A. Monthly, the contractor shall submit the AIA application and certificate for payment documents G702 & G703 reflecting updated schedule activities and cost data in accordance with the provisions of the following Article, PAYMENT AND PROGRESS REPORTING, as the basis upon which progress payments will be made pursuant to Article, FAR 52.232 – 5 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS) and VAAR 852.236 – 83 (PAYMENT UNDER FIXED-PRICE CONSTRUCTION CONTRACTS). The Contractor shall be entitled to a monthly progress payment upon approval of estimates as determined from the currently approved updated project schedule. Monthly payment requests shall include: a listing of all agreed upon project schedule changes and associated data; and an electronic file (s) of the resulting monthly updated schedule.
- B. Approval of the Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly update of the project schedule.

#### **1.9 PAYMENT AND PROGRESS REPORTING**

- A. Monthly schedule update meetings will be held on dates mutually agreed to by the COR and the Contractor. Contractor and their CPM consultant (if applicable) shall attend all monthly schedule update meetings. The Contractor shall accurately update the Project Schedule and all other data required and provide this information to the COR three work days in advance of the schedule update meeting. Job progress will be reviewed to verify:
  1. Actual start and/or finish dates for updated/completed activities/events.
  2. Remaining duration for each activity/event started, or scheduled to start, but not completed.

3. Logic, time and cost data for change orders, and supplemental agreements that are to be incorporated into the Project Schedule.
  4. Changes in activity/event sequence and/or duration which have been made, pursuant to the provisions of following Article, ADJUSTMENT OF CONTRACT COMPLETION.
  5. Completion percentage for all completed and partially completed activities/events.
  6. Logic and duration revisions required by this section of the specifications.
  7. Activity/event duration and percent complete shall be updated independently.
- B. After completion of the joint review, the contractor shall generate an updated computer-produced calendar-dated schedule and supply the Contracting Officer's representative with reports in accordance with the Article, COMPUTER PRODUCED SCHEDULES, specified.
- C. After completing the monthly schedule update, the contractor's representative or scheduling consultant shall rerun all current period contract change(s) against the prior approved monthly project schedule. The analysis shall only include original workday durations and schedule logic agreed upon by the contractor and COR for the contract change(s). When there is a disagreement on logic and/or durations, the Contractor shall use the schedule logic and/or durations provided and approved by the COR. After each rerun update, the resulting electronic project schedule data file shall be appropriately identified and submitted to the VA in accordance to the requirements listed in articles 1.4 and 1.7. This electronic submission is separate from the regular monthly project schedule update requirements and shall be submitted to the COR within fourteen (14) calendar days of completing the regular schedule update. **Before inserting the contract changes durations, care must be taken to ensure that only the original durations will be used for the analysis, not the reported durations after progress. In addition, once the final network diagram is approved, the contractor must recreate all manual progress payment updates on this approved network diagram and associated reruns for contract changes in each of these update periods as outlined above for regular update periods. This will require detailed record keeping for each of the manual progress payment updates.**
- D. Following approval of the CPM schedule, the VA, the General Contractor, its approved CPM Consultant, COR office representatives, and all subcontractors needed, as determined by the SRE, shall meet to discuss the monthly updated schedule. The main emphasis shall be to address work activities to avoid slippage of project schedule and to identify any necessary actions required to maintain project schedule during the reporting period. The Government representatives and the Contractor should conclude the meeting with a clear understanding of those work and administrative actions necessary to maintain project schedule status during the reporting period. This schedule coordination meeting will occur after each monthly project schedule update meeting utilizing the resulting schedule reports from that schedule update. If the

project is behind schedule, discussions should include ways to prevent further slippage as well as ways to improve the project schedule status, when appropriate.

#### **1.10 RESPONSIBILITY FOR COMPLETION**

- A. If it becomes apparent from the current revised monthly progress schedule that phasing or contract completion dates will not be met, the Contractor shall execute some or all of the following remedial actions:
  - 1. Increase construction manpower in such quantities and crafts as necessary to eliminate the backlog of work.
  - 2. Increase the number of working hours per shift, shifts per working day, working days per week, the amount of construction equipment, or any combination of the foregoing to eliminate the backlog of work.
  - 3. Reschedule the work in conformance with the specification requirements.
- B. Prior to proceeding with any of the above actions, the Contractor shall notify and obtain approval from the COR for the proposed schedule changes. If such actions are approved, the representative schedule revisions shall be incorporated by the Contractor into the Project Schedule before the next update, at no additional cost to the Government.

#### **1.11 CHANGES TO THE SCHEDULE**

- A. Within 30 calendar days after VA acceptance and approval of any updated project schedule, the Contractor shall submit a revised electronic file (s) and a list of any activity/event changes including predecessors and successors for any of the following reasons:
  - 1. Delay in completion of any activity/event or group of activities/events, which may be involved with contract changes, strikes, unusual weather, and other delays will not relieve the Contractor from the requirements specified unless the conditions are shown on the CPM as the direct cause for delaying the project beyond the acceptable limits.
  - 2. Delays in submittals, or deliveries, or work stoppage are encountered which make rescheduling of the work necessary.
  - 3. The schedule does not represent the actual prosecution and progress of the project.
  - 4. When there is, or has been, a substantial revision to the activity/event costs regardless of the cause for these revisions.
- B. CPM revisions made under this paragraph which affect the previously approved computer-produced schedules for Government furnished equipment, vacating of areas by the VA Facility, contract phase(s) and sub phase(s), utilities furnished by the Government to the Contractor, or any other previously contracted item, shall be furnished in writing to the Contracting Officer for approval.
- C. Contracting Officer's approval for the revised project schedule and all relevant data is contingent upon compliance with all other paragraphs of this section and any other previous agreements by the Contracting Officer or the VA representative.

- D. The cost of revisions to the project schedule resulting from contract changes will be included in the proposal for changes in work as specified in FAR 52.243 – 4 (Changes) and VAAR 852.236 – 88 (Changes – Supplemental), and will be based on the complexity of the revision or contract change, man hours expended in analyzing the change, and the total cost of the change.
- E. The cost of revisions to the Project Schedule not resulting from contract changes is the responsibility of the Contractor.

#### **1.12 ADJUSTMENT OF CONTRACT COMPLETION**

- A. The contract completion time will be adjusted only for causes specified in this contract. Request for an extension of the contract completion date by the Contractor shall be supported with a justification, CPM data and supporting evidence as the COR may deem necessary for determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof based on revised activity/event logic, durations (in work days) and costs is obligatory to any approvals. The schedule must clearly display that the Contractor has used, in full, all the float time available for the work involved in this request. The Contracting Officer's determination as to the total number of days of contract extension will be based upon the current computer-produced calendar-dated schedule for the time period in question and all other relevant information.
- B. Actual delays in activities/events which, according to the computer- produced calendar-dated schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network, will not be the basis for a change to the contract completion date. The Contracting Officer will within a reasonable time after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing of the Contracting Officer's decision.
- C. The Contractor shall submit each request for a change in the contract completion date to the Contracting Officer in accordance with the provisions specified under FAR 52.243 – 4 (Changes) and VAAR 852.236 – 88 (Changes – Supplemental). The Contractor shall include, as a part of each change order proposal, a sketch showing all CPM logic revisions, duration (in work days) changes, and cost changes, for work in question and its relationship to other activities on the approved network diagram.
- D. All delays due to non-work activities/events such as RFI's, WEATHER, STRIKES, and similar non-work activities/events shall be analyzed on a month by month basis.

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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, 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 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 COR 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 COR and to Architect-Engineer simultaneously with submission of material to a commercial testing laboratory.
    - 5. Laboratory test reports shall be sent directly to COR 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 COR 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

Heapy Engineering  
1400 W. Dorothy Lane  
Dayton, OH 45409

- 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 COR.

--- E N D ---

**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:

DEPARTMENT 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.aabchg.com>

AAMA	American Architectural Manufacturer's Association <a href="http://www.aamanet.org">http://www.aamanet.org</a>
AAN	American Nursery and Landscape Association <a href="http://www.anla.org">http://www.anla.org</a>
AASHTO	American Association of State Highway and Transportation Officials <a href="http://www.aashto.org">http://www.aashto.org</a>
AATCC	American Association of Textile Chemists and Colorists <a href="http://www.aatcc.org">http://www.aatcc.org</a>
ACGIH	American Conference of Governmental Industrial Hygienists <a href="http://www.acgih.org">http://www.acgih.org</a>
ACI	American Concrete Institute <a href="http://www.aci-int.net">http://www.aci-int.net</a>
ACPA	American Concrete Pipe Association <a href="http://www.concrete-pipe.org">http://www.concrete-pipe.org</a>
ACPPA	American Concrete Pressure Pipe Association <a href="http://www.acppa.org">http://www.acppa.org</a>
ADC	Air Diffusion Council <a href="http://flexibleduct.org">http://flexibleduct.org</a>
AGA	American Gas Association <a href="http://www.agas.org">http://www.agas.org</a>
AGC	Associated General Contractors of America <a href="http://www.agc.org">http://www.agc.org</a>
AGMA	American Gear Manufacturers Association, Inc. <a href="http://www.agma.org">http://www.agma.org</a>
AHAM	Association of Home Appliance Manufacturers <a href="http://www.aham.org">http://www.aham.org</a>
AISC	American Institute of Steel Construction <a href="http://www.aisc.org">http://www.aisc.org</a>
AISI	American Iron and Steel Institute <a href="http://www.steel.org">http://www.steel.org</a>
AITC	American Institute of Timber Construction <a href="http://www.aitc-glulam.org">http://www.aitc-glulam.org</a>
AMCA	Air Movement and Control Association, Inc. <a href="http://www.amca.org">http://www.amca.org</a>
ANLA	American Nursery & Landscape Association <a href="http://www.anla.org">http://www.anla.org</a>

ANSI	American National Standards Institute, Inc. <a href="http://www.ansi.org">http://www.ansi.org</a>
APA	The Engineered Wood Association <a href="http://www.apawood.org">http://www.apawood.org</a>
ARI	Air-Conditioning and Refrigeration Institute <a href="http://www.ari.org">http://www.ari.org</a>
ASAE	American Society of Agricultural Engineers <a href="http://www.asae.org">http://www.asae.org</a>
ASCE	American Society of Civil Engineers <a href="http://www.asce.org">http://www.asce.org</a>
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers <a href="http://www.ashrae.org">http://www.ashrae.org</a>
ASME	American Society of Mechanical Engineers <a href="http://www.asme.org">http://www.asme.org</a>
ASSE	American Society of Sanitary Engineering <a href="http://www.asse-plumbing.org">http://www.asse-plumbing.org</a>
ASTM	American Society for Testing and Materials <a href="http://www.astm.org">http://www.astm.org</a>
AWI	Architectural Woodwork Institute <a href="http://www.awinet.org">http://www.awinet.org</a>
AWS	American Welding Society <a href="http://www.aws.org">http://www.aws.org</a>
AWWA	American Water Works Association <a href="http://www.awwa.org">http://www.awwa.org</a>
BHMA	Builders Hardware Manufacturers Association <a href="http://www.buildershardware.com">http://www.buildershardware.com</a>
BIA	Brick Institute of America <a href="http://www.bia.org">http://www.bia.org</a>
CAGI	Compressed Air and Gas Institute <a href="http://www.cagi.org">http://www.cagi.org</a>
CGA	Compressed Gas Association, Inc. <a href="http://www.cganet.com">http://www.cganet.com</a>
CI	The Chlorine Institute, Inc. <a href="http://www.chlorineinstitute.org">http://www.chlorineinstitute.org</a>
CISCA	Ceilings and Interior Systems Construction Association <a href="http://www.cisca.org">http://www.cisca.org</a>

CISPI	Cast Iron Soil Pipe Institute <a href="http://www.cispi.org">http://www.cispi.org</a>
CLFMI	Chain Link Fence Manufacturers Institute <a href="http://www.chainlinkinfo.org">http://www.chainlinkinfo.org</a>
CPMB	Concrete Plant Manufacturers Bureau <a href="http://www.cpmc.org">http://www.cpmc.org</a>
CRA	California Redwood Association <a href="http://www.calredwood.org">http://www.calredwood.org</a>
CRSI	Concrete Reinforcing Steel Institute <a href="http://www.crsi.org">http://www.crsi.org</a>
CTI	Cooling Technology Institute <a href="http://www.cti.org">http://www.cti.org</a>
DHI	Door and Hardware Institute <a href="http://www.dhi.org">http://www.dhi.org</a>
EGSA	Electrical Generating Systems Association <a href="http://www.egsa.org">http://www.egsa.org</a>
EEI	Edison Electric Institute <a href="http://www.eei.org">http://www.eei.org</a>
EPA	Environmental Protection Agency <a href="http://www.epa.gov">http://www.epa.gov</a>
ETL	ETL Testing Laboratories, Inc. <a href="http://www.et1.com">http://www.et1.com</a>
FAA	Federal Aviation Administration <a href="http://www.faa.gov">http://www.faa.gov</a>
FCC	Federal Communications Commission <a href="http://www.fcc.gov">http://www.fcc.gov</a>
FPS	The Forest Products Society <a href="http://www.forestprod.org">http://www.forestprod.org</a>
GANA	Glass Association of North America <a href="http://www.cssinfo.com/info/gana.html/">http://www.cssinfo.com/info/gana.html/</a>
FM	Factory Mutual Insurance <a href="http://www.fmglobal.com">http://www.fmglobal.com</a>
GA	Gypsum Association <a href="http://www.gypsum.org">http://www.gypsum.org</a>
GSA	General Services Administration <a href="http://www.gsa.gov">http://www.gsa.gov</a>

HI	Hydraulic Institute <a href="http://www.pumps.org">http://www.pumps.org</a>
HPVA	Hardwood Plywood & Veneer Association <a href="http://www.hpva.org">http://www.hpva.org</a>
ICBO	International Conference of Building Officials <a href="http://www.icbo.org">http://www.icbo.org</a>
ICEA	Insulated Cable Engineers Association Inc. <a href="http://www.icea.net">http://www.icea.net</a>
ICAC	Institute of Clean Air Companies <a href="http://www.icac.com">http://www.icac.com</a>
IEEE	Institute of Electrical and Electronics Engineers <a href="http://www.ieee.org/">http://www.ieee.org/</a>
IMSA	International Municipal Signal Association <a href="http://www.imsasafety.org">http://www.imsasafety.org</a>
IPCEA	Insulated Power Cable Engineers Association
NBMA	Metal Buildings Manufacturers Association <a href="http://www.mbma.com">http://www.mbma.com</a>
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry Inc. <a href="http://www.mss-hq.com">http://www.mss-hq.com</a>
NAAMM	National Association of Architectural Metal Manufacturers <a href="http://www.naamm.org">http://www.naamm.org</a>
NAPHCC	Plumbing-Heating-Cooling Contractors Association <a href="http://www.phccweb.org.org">http://www.phccweb.org.org</a>
NBS	National Bureau of Standards See - NIST
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors <a href="http://www.nationboard.org">http://www.nationboard.org</a>
NEC	National Electric Code See - NFPA National Fire Protection Association
NEMA	National Electrical Manufacturers Association <a href="http://www.nema.org">http://www.nema.org</a>
NFPA	National Fire Protection Association <a href="http://www.nfpa.org">http://www.nfpa.org</a>
NHLA	National Hardwood Lumber Association <a href="http://www.natlhardwood.org">http://www.natlhardwood.org</a>
NIH	National Institute of Health <a href="http://www.nih.gov">http://www.nih.gov</a>

NIST	National Institute of Standards and Technology <a href="http://www.nist.gov">http://www.nist.gov</a>
NLMA	Northeastern Lumber Manufacturers Association, Inc. <a href="http://www.nelma.org">http://www.nelma.org</a>
NPA	National Particleboard Association 18928 Premiere Court Gaithersburg, MD 20879 (301) 670-0604
NSF	National Sanitation Foundation <a href="http://www.nsf.org">http://www.nsf.org</a>
NWWDA	Window and Door Manufacturers Association <a href="http://www.nwwda.org">http://www.nwwda.org</a>
OSHA	Occupational Safety and Health Administration Department of Labor <a href="http://www.osha.gov">http://www.osha.gov</a>
PCA	Portland Cement Association <a href="http://www.portcement.org">http://www.portcement.org</a>
PCI	Precast Prestressed Concrete Institute <a href="http://www.pci.org">http://www.pci.org</a>
PPI	The Plastic Pipe Institute <a href="http://www.plasticpipe.org">http://www.plasticpipe.org</a>
PEI	Porcelain Enamel Institute, Inc. <a href="http://www.porcelainenamel.com">http://www.porcelainenamel.com</a>
PTI	Post-Tensioning Institute <a href="http://www.post-tensioning.org">http://www.post-tensioning.org</a>
RFCI	The Resilient Floor Covering Institute <a href="http://www.rfci.com">http://www.rfci.com</a>
RIS	Redwood Inspection Service See - CRA
RMA	Rubber Manufacturers Association, Inc. <a href="http://www.rma.org">http://www.rma.org</a>
SCMA	Southern Cypress Manufacturers Association <a href="http://www.cypressinfo.org">http://www.cypressinfo.org</a>
SDI	Steel Door Institute <a href="http://www.steeldoor.org">http://www.steeldoor.org</a>
IGMA	Insulating Glass Manufacturers Alliance <a href="http://www.igmaonline.org">http://www.igmaonline.org</a>



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>

TCA Tile Council of 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>

WCLIB West Coast Lumber Inspection Bureau

6980 SW Varns Road, P.O. Box 23145

Portland, OR 97223

(503) 639-0651

WRCLA Western Red Cedar Lumber Association

P.O. Box 120786

New Brighton, MN 55112

(612) 633-4334

WWPA Western Wood Products Association

<http://www.wwpa.org>

--- E N D ---

**SECTION 02 41 00  
DEMOLITION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies demolition and removal of portions of buildings, utilities, other structures and debris from trash dumps 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. 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. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- D. 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.
- E. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
  - 1. 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.
  - 2. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.

- F. 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 COR. 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 COR's approval.
- G. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS, Article 1.7 INFECTION PREVENTION MEASURES.

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

**PART 3 – EXECUTION**

**3.1 DEMOLITION:**

- A. 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 COR. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- B. Remove and legally dispose of all materials. 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

**3.2 CLEAN-UP:**

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

- - - E N D - - -

**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**

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**

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<sup>2</sup> (16 sq. in.) in overall cross sectional area.
- C. Products requiring heat activation to seal an opening by its intumescence shall exhibit a demonstrated ability to function as designed to maintain the fire barrier.
- D. Firestop sealants used for firestopping or smoke sealing shall have following properties:
  - 1. Contain no flammable or toxic solvents.
  - 2. Have no dangerous or flammable out gassing during the drying or curing of products.
  - 3. Water-resistant after drying or curing and unaffected by high humidity, condensation or transient water exposure.
  - 4. When used in exposed areas, shall be capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.
- E. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials shall have following properties:
  - 1. Classified for use with the particular type of penetrating material used.
  - 2. Penetrations containing loose electrical cables, computer data cables, and communications cables protected using firestopping systems that allow unrestricted cable changes without damage to the seal.
  - 3. Intumescent products which would expand to seal the opening and act as fire, smoke, toxic fumes, and, water sealant.
- F. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84.
- G. FM, UL, or WH rated or tested by an approved laboratory in accordance with 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 COR.
- C. Clean up spills of liquid type materials.

--- E N D ---

**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. Firestopping penetrations: Section 07 84 00, FIRESTOPPING.
- B. Mechanical Work: Section 23 05 11, COMMON WORK RESULTS FOR HVAC, BOILER PLANT, 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 elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
  - 3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
  - 4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to joint substrates in accordance with sealant manufacturer's recommendations:
  - 1. Locate test joints where indicated or, if not indicated, as directed by Contracting Officer.
  - 2. Conduct field tests for each application indicated below:
    - a. Each type of elastomeric sealant and joint substrate indicated.
    - b. Each type of non-elastomeric sealant and joint substrate indicated.
  - 3. Notify COR 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.

**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. 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 °C (40 °F).
    - b. When joint substrates are wet.
- B. Joint-Width Conditions:
  - 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions:
  - 1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

**1.6 DELIVERY, HANDLING, AND STORAGE:**

- A. Deliver materials in manufacturers' original unopened containers, with brand names, date of manufacture, shelf life, and material designation clearly marked thereon.
- B. Carefully handle and store to prevent inclusion of foreign materials.
- C. Do not subject to sustained temperatures exceeding 32° C (90° F) or less than 5° C (40° F).

**1.7 DEFINITIONS:**

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.
- C. Bond Breakers: A type of sealant backing.
- D. Filler: A sealant backing used behind a back-up rod.

**1.8 WARRANTY:**

- A. Warranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Warranty of Construction", FAR clause 52.246-21, 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, acetoxycure.
  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. ASTM 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° C and 38° C (40° and 100° 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.
- 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.

### **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 and C-2.
  2. Perimeter of Doors, Windows, Access Panels which Adjoin Concrete or Masonry Surfaces: Types C-1 and C-2.
  3. Joints at Masonry Walls and Columns, Piers, Concrete Walls or Exterior Walls: Types C-1 and C-2.
  4. Perimeter of Lead Faced Control Windows and Plaster or Gypsum Wallboard Walls: Types C-1 and C-2.
  5. Exposed Isolation Joints at Top of Full Height Walls: Types C-1 and C-2.
  6. Exposed Acoustical Joint at Sound Rated Partitions Type C-2.
  7. Concealed Acoustic Sealant Types S-4, C-1 and C-2.

--- E N D ---



**SECTION 23 05 11  
COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
  - 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. COR: Contracting Officer's Representative.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- C. Section 07 84 00, FIRESTOPPING
- D. Section 07 92 00, JOINT SEALANTS
- E. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- H. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

**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. Equipment shall be factory-balanced to manufacturer's required tolerance and re-balanced on site, as necessary. Refer to Section 23 15 00.
  - 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- 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. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
  3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Contracting Officer's Representative (COR).
  4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
  5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
  7. Asbestos products or equipment or materials containing asbestos shall not be used.
  8. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for quality assurance requirements for boiler plant combustion controller and plant master controller software.
- D. Equipment Service Organizations:
1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.
  2. Boiler Plants: Service organizations, authorized and trained by the manufacturers of the controls 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 controls; 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): combustion control systems, plant master control systems, critical instrumentation, and programming.
- E. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".

3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- F. 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 COR for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the COR 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 COR for resolution.
- G. 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 approval will be made only by groups.
- F. Submittal "Groups" for boiler plant work are defined in the following checklist:

1. Group IV (Boiler Combustion Controls, Plant Master Controls, and Boiler Plant Controls and Instrumentation): Boiler combustion control system, Plant master control system, control and instrument panels and accessories, associated controllers and software, instrumentation, tools.
- G. Samples: Samples will not be required, except where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided in the GENERAL CONDITIONS.
- H. Mock-ups: Mock-ups are required for critical items and typical component installations replicated numerous times throughout the project as directed by the COR. The COR and Medical Center Representatives shall review and approve the mock-up prior to installation of additional applicable components.
- I. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
  1. Submit belt drive with the driven equipment.
  2. Submit electric motor data with the driven equipment.
  3. Equipment and materials identification.
  4. Fire-stopping materials.
  5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.
- J. HVAC Maintenance Data and Operating Instructions:
  1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
  2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- K. Boiler Plant Maintenance Data and Operating Instructions:
  1. Provide four bound copies. Deliver to COR 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, 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.

#### **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 COR. 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. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

**1.7 JOB CONDITIONS – WORK IN EXISTING BUILDING/BOILER PLANT**

- A. Building/Plant Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities, that serve the medical center.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center. At all times there shall be at least 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 COR 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 COR.
- D. Phasing of Work: Comply with all requirements shown on drawings or specified.
- E. Building/Plant Working Environment: Maintain the architectural and structural integrity of the building/plant and the working environment at all times. Maintain the interior of building/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 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.



## **2.4 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.

## **2.5 ELECTRIC MOTORS**

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. 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.

## **2.6 BOILER PLANT CONTROLS AND INSTRUMENTATION**

- A. Provide, and place into proper operation, complete controls systems as specified in 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.

## **2.7 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping and ductwork is specified in Paragraph 3.7 below.
- 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, 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. HVAC and Boiler Plant: Provide for all new 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.

## **2.8 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.

## **2.9 GALVANIZED REPAIR COMPOUND**

Mil. Spec. DOD-P-21035B, paint form.

## **2.10 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Provide as required by equipment manufacturer.
- B. Supports for Roof Mounted Items:
  1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69.
- D. Attachment to Concrete Building Construction:
  1. Concrete insert: MSS SP-58, Type 18.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the COR for each job condition.
  3. Power-driven fasteners: Not permitted.
- E. Attachment to Steel Building Construction:
  1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.
- F. Attachment to Metal Pan or Deck: As required for existing materials.
- G. Attachment to existing structure: Support from existing floor/roof frame.
- H. Attachment to Wood Construction: Wood screws or lag bolts.
- I. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

- J. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
  2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- K. Supports for Piping Systems:
1. Select hangers sized to encircle insulation on insulated piping. 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.
  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.
- L. Pre-insulated Calcium Silicate Shields:
1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
    - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
  5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

## **2.11 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
  2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of COR.
- 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. 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.

## **2.12 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- 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.

## **2.13 SPECIAL TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the COR, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- E. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

## **2.14 WALL, FLOOR AND CEILING PLATES**

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.

- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.15 ASBESTOS**

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. 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.
- D. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by COR 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 COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  - 3. Do not penetrate membrane waterproofing.
- G. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. Electrical and Pneumatic Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers,

control devices, control and instrumentation panels, instruments and computer workstations.

Comply with NFPA-70.

J. Protection and Cleaning:

1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

K. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum.

L. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

M. Work in Existing Building:

1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the COR. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the COR for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After COR's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.

N. 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 not be located in the

space equal to the width and depth of the equipment and extending from the floor to a height of 1.8 m (6 ft.) above the equipment or to structural ceiling, whichever is lower (NFPA 70).

O. 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 COR 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 COR.
- 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 rest 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. 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.

### **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 COR. 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 COR 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 COR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

### **3.6 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted.
- 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. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. Paint shall withstand the following temperatures without peeling or discoloration:
  - a. Condensate -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
  - b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
7. 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. Pipe Identification: Pipe marking shall be applied to all pipes after insulation and painting has been completed, and shall be as follows:
  - 1. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl markers.
  - 2. On piping and insulation 6" and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50" wide, full circle at both ends of the marker
  - 3. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.
- D. Duct Identification: Duct marking shall be applied to all ducts, after insulation and painting has been completed, and shall be as follows:
  - 1. Laminated plastic color-coded pressure sensitive vinyl tape, 2.50" width, 3 mils minimum thickness. Identification shall include service (supply, return, exhaust, outside air) and direction of flow.
  - 2. Duct access panel markings shall be similar to duct markings to identify the device (fire damper, smoke damper, control damper, smoke detector, etc.
  - 3. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.
- E. For pipe & duct labeling, coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings. Pipe and duct markings shall be placed:
  - 1. At each piece of equipment.
  - 2. At 25 ft. centers in mechanical rooms and concealed spaces, but at least once per room.
  - 3. At 50 ft. centers in other exposed locations.
  - 4. On mains at each branch take-off.
  - 5. On duct access panels.
- F. Boiler Plant Instrumentation Panel: Refer to Section 23 09 11.
- G. Boiler Control Panels: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

### **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 COR 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 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.

### **3.11 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 COR.
- 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.

### **3.12 INSTRUCTIONS TO VA PERSONNEL**

Provide in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

--- E N D ---

**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.
- B. Instruction of Government operating personnel.
- C. All demonstrations, instructions and testing must be completed prior to Government acceptance for beneficial use.
- D. Coordinate all requirements of this section with Demonstration, Testing, and Instruction requirements specified in Section 23 09 11.

**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 Contracting Officer's Representative (COR) is not required.
- C. Final Tests: Tests, witnessed by the COR 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 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT: Demonstration and testing of boiler plant instrumentation and controls

**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. Control systems.
- B. Experienced technicians shall demonstrate and provide instructions on the following equipment:
  - 1. Control and safety valves
- C. The person responsible for programming the boiler combustion controllers and plant master controller shall demonstrate and provide instructions on hardware, software and programming.
- D. The COR, 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 combustion control and plant master control pre-test data as specified.
- D. Preliminary schedule of all demonstrations 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.

### **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 control. Complete all construction and finish work.
- B. Arrange for all test personnel for all controls to be continuously present during one period of time so that all equipment and systems control can be tested in their interrelated functions.
- 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 control of each equipment and system.
- B. Provide tests on equipment controls as specified in 23 09 11.

#### **3.3 STARTUP AND TESTING**

- A. The COR and VA Boiler Plant Operator will observe startup and contractor testing of equipment controls. Coordinate the startup and contractor testing schedules with the COR. Provide a minimum of 7 days prior notice.

#### **3.4 DEMONSTRATIONS AND TRAINING**

- A. Demonstrate operation and maintenance of equipment and systems control 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 all combustion controls and plant master controls. 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 videos to the COR, in DVD format. DVD shall be divided into segments separating different instruction/training topics and shall have menu interface, to choose a desired topic from a list, so that instructions on a specific topic are able to be quickly referenced by VA boiler plant personnel in the future.

### **3.5 TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS**

- A. As specified in Paragraph 3.4-A of Section 23 09 11, to include plant master controls, combustion controls, instrumentation.
- B. Maximum number of trainees per session shall be dictated by COR. Do not exceed one-four hour session, per day, per trainee.

--- E N D ---



**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, and data management and instrumentation systems.

**1.2 RELATED WORK:**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, BOILER PLANT, AND STEAM GENERATION.

**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 and induced draft fan drives.
- C. Equipment Experience Requirements: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, BOILER PLANT, AND STEAM GENERATION.
- D. Code Approval:
  - 1. All combustion control systems and devices shall comply with NFPA 85.
  - 2. Parallel positioning combustion control systems shall comply with UL 1998.
  - 3. 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.
  - 4. All electrical wiring shall be in accordance with NFPA 70.
- E. Personnel: All work shall be performed 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, C & E). 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 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.
  - 4. Complete wiring and piping diagrams for all equipment and systems.
  - 5. 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.
- G. As-built Logic and Wiring Diagrams: One set of reproducible prints and CAD disks delivered to Contracting Officer's Representative (COR) prior to turning systems over to VA for operation.

Supply revised drawings if changes are made during the startup and testing/demonstration process.

### 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 industrial-process-grade multi-loop programmable microprocessor-based.
  - 2. Controllers shall be manufactured separate from and shall be separate assemblies from the Burner Management (Flame Safeguard System), and shall control all required boiler functions except Burner Management (Flame Safeguard) System. Burner Management (Flame Safeguard) System shall not be implemented in the same CPU or control platform as Combustion Control System (CCS) or level control.
  - 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. Boiler outlet draft.
  - d. Boiler water level, 2 element system.
- 4. Control features:
  - a. Operator interface on 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. Each boiler shall have its own separate dedicated controllers incorporating fuel/air control loops, oxygen trim, draft control and water level control. A separate dedicated controller shall be provided for master steam pressure control with fallback / failover pressure control tied to drum pressure.
  - c. Variable frequency drives on forced draft and induced draft fan motors are existing to remain, and shall be integrated into new boiler controllers.
- 5. Refer to the paragraphs which follow for complete detailed requirements.
- B. Controllers: Multiple-loop programmable microprocessor-based, proportional-integral-differential (PID) solid state electronic controllers shall control all functions except burner management.
  - 1. The controller shall be capable of performing all control functions in the event of failure of the touch screen interface.
  - 2. There shall be a built-in Real Time & Data Clock that continues keeping time & data when power is removed.
  - 3. Memory shall be non-volatile RAM that will store current process parameters as well as the configured database when power is removed, for a period of at least one year.
  - 4. A portable backup memory device consisting of non-volatile RAM shall be available, which stores the controller database including all current setup parameters, output states and process parameters every 50ms when installed on the operating controller. Checksums shall be performed to prevent database corruption and the device can be used to load a replacement controller with the current database and process parameters including but not limited to ranges, alarm limits, and all rations and curve points. Memory retention (unpowered) of the backup device shall be not less than seven years.
  - 5. Controllers shall support multiple data types including full IEEE floating point with six digit precision to avoid scaling of inputs.
  - 6. Controller shall support individual, single-channel inputs and outputs without external cards, racks, cables or termination blocks.
  - 7. All analog inputs and outputs shall be individually isolated on a per-point basis to 250V rms.

8. All current inputs that require transmitter power supplies shall have individual, built-in isolated transmitter power supplies for each point.
  9. Analog inputs shall have a minimum resolution of 14 bits to provide a minimum accuracy of  $\pm 0.2\%$  and sensitivity of  $\pm 0.2\%$ .
  10. To allow free placement of DO and DI contacts at the plant's electrical systems all digital inputs and outputs are to be individually isolated to at least 250V rms with no common terminals.
  11. The controller shall include a local alarm/event log of up to 1024 entries with time and date of occurrence, acknowledgement and clearance of process alarms as well as diagnostic alarms, power up/down status and instrument state on a first-in, first-out basis.
  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 the control system for one boiler shall not affect automatic or manual operation of other boilers or the plant master.
  13. Environment: 0 to 50 degrees C, 15% to 95% RH, non-condensing.
  14. Password Protection: Provide levels of password protection for all safety related options and parameters including all startup/testing programming. Provide all passwords to Contracting Officer's Representative (COR).
  15. Controllers shall provide serial RS232/RS485 Modbus communication for integration into future computer workstation (SCADA) that shall be capable of data gathering and processing, report generation, monitoring, annunciation and control. Provide configured list in controller programming, for easy future integration into SCADA. It shall be possible to defeat the remote control from the Human Machine Interface (HMI) touch screen of each individual controller, preventing any status changes from being initiated at the computer workstation.
  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.
- 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. HMI touch screens from all boiler controllers shall communicate with all other boiler controllers, so that any HMI touch screen can operate any boiler controller in the plant, in the event that a touch screen fails. HMI touch screen display shall default to

its associated boiler controller, but shall include option for user to temporarily override this default, to select which controller is being temporarily displayed.

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 systems.
- b. Selection of automatic or manual control of firing rate. Local manual control to increase and decrease the firing rate.
- c. 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.
- d. Display of all control system alarm messages and faults. History of alarms and faults and recommendations for troubleshooting.
- e. Complete display and facilities to allow parameterization or set-up for all controllers associated with the boiler or the master control. Burner management is excluded from this requirement.
- f. If touch screens are not tied together as described in 2.1-D-1 above, provide one spare touch screen to VA, and alternate means of automatic and manual operation of boiler firing rates and burner management status if touch-screen fails.
- g. 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. 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. Ability to communicate with future SCADA program on computer work station.
- d. Multiple RS-485 Modbus communication ports that support multiple protocols including Modbus.
- e. Ability to interface to and communicate with a minimum of five separate types of devices using different communication protocols.
- f. 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.

- g. 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.
  - h. Show facsimiles of each standard PID-style controller graphics with clearly labeled English language and engineering unit display of the control parameters.
  - i. 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. Operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point.
  - j. 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 Fuel Flow Control Valves (applies to Boiler #4):
- 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.
- F. Variable Frequency Drives (VFD) for Forced Draft and Induced Draft Fans (existing):

1. 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.
  2. Provide noise filters.
  3. The VFD shall be re-programmed as required to 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%.
  4. Provide constant speed feature and operator-selectable air/fuel program in the controller for constant speed operation maintaining specified air/fuel ratios (excess air).
  5. Operation of Forced draft and Induced Draft damper operation is required in conjunction with operation of the FD & ID fan VFDs at the lower firing rates.
- G. Transmitters: See Paragraphs, PRESSURE SENSORS AND TRANSMITTERS, TEMPERATURE SENSORS AND TRANSMITTERS.
- H. 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.
- I. Spare Parts and Tools:
1. Hardware and software sufficient for downloading and uploading all programming configurations with all the controllers (spare removable EEPROMs for each individual boiler and control and HMI device, containing each boiler's configuration and unique air/fuel ratios, curves, tuning parameter, spans and deadbands. Additionally, that are continually updated every 50-250 mS and reside onboard for this specific purpose).
- J. 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 existing 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 125 psi.  
Individual set point adjustment range: +/- 20 psi.
  - c. Control Stations: Individual control stations for master and submaster controllers. Locate control stations on main instrumentation panel unless otherwise shown.
  - d. Low fire hold capability and user definable optimum ignition position, for each fuel independently.
  - e. Interface with burner management system for automatic positioning of forced draft and induced draft fan dampers, forced draft and induced draft fan speeds and fuel flow control valves during pre-purge, ignition, shutdown and post-purge.
  - f. Interlocks to prove proper positions of forced draft & induced draft fan dampers, forced draft and induced draft fan speeds, and fuel flow control valves for ignition and running cycles.
  - g. A lead/lag function shall be available that brings boiler online automatically as plant demand requires, and automatically shuts down the boilers running at minimum load when plant demand decreases. It shall be possible to set the boiler lead/lag sequence and a deadband on the load points from the front panel of the controller. A steam flow feedforward calculation shall also be available to anticipate changes in plant demand.
  - h. When all of the Boiler Master controllers are in either Manual or Track mode, the plant master controller shall automatically switch to Track mode with its output following the highest Boiler Master demand signal, and the setpoint tracking plant pressure demand. When any one of the Boiler Master controllers switches to Automatic mode the plant master controller shall switch into Manual mode and begin tracking, to provide automatic transfer back to Automatic control with no disturbance ("bumpless" control). The operator shall not be required to balance the control loops to provide a smooth transition.
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. Controller shall not allow the system to be improperly placed in manual.
- 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 must be minimized and submitted for approval as a deviation to the contract.
- i. 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 Contracting Officer's Representative (COR) if flue gas carbon monoxide exceeds 200 parts per million (ppm) within the excess air limits specified above.
- j. Controller shall provide integration and tantalization of Feedwater Flow and Steam Flow. A low-flow cutoff shall be included to prevent errors at low flows. Values shall be available to the touch screen interface and SCADA system for display and logging. Separate indication of shift and continuous totals shall be provided with the ability to clear the shift total from the operating display. Clearing of continuous total shall be password protected.

3. Automatic Flue Gas Oxygen Trim System:
  - a. Boiler/burner submaster air/fuel controller shall utilize 4-20 mA signal from existing 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. Program shall include trim limits.
    - 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. Boiler Outlet Draft Control:
  - a. Automatically modulate variable frequency drive (VFD) of the induced draft fan, and position of boiler 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. Draft sensor, transmitter, and outlet damper actuator for each boiler.
  - d. Automatically modulate variable frequency drive (VFD) of the induced draft fan, and position damper as required for pre-purge, burner ignition and shut down. Provide damper position switch interlocked with burner management system.
5. 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) Two-Element System: Utilize existing boiler steam flow signal and existing boiler water level signal. Adjustable signal gain. Provide single-element (drum level) operation from low fire to 20% of maximum boiler load. Provide automatic switchover from single-element to two-element operation.
  - c. Boiler Water Level Sensors: existing to remain.
  - d. Steam Flow Sensors: existing to remain.
  - e. Controller: Controllers for two element systems shall include: manual/auto control station and indicators showing signal level to actuator, set point and actual water level, and steam flow rates and totals. Locate on main instrumentation panel unless otherwise shown.
  - f. Set point position as recommended by boiler manufacturer.
6. 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 MAIN INSTRUMENTATION AND CONTROL PANEL:**

- A. Free-standing steel enclosure with control stations, control switches, instruments and indicators on panel front is existing to remain. Refer to drawings for location of existing panel and overall dimensions.
- B. Master Steam Pressure Control Station: Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS. Unit shall be flush mounted on existing main panel front.
- C. Recording Systems: Refer to Paragraph, RECORDERS.
- D. Touch Screens: Refer to Paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM.
- E. Push Button Stations and Indication Lights for Pump Control: existing to remain.
- F. Boiler Economizer Temperature Indicator Systems: sensing devices are existing to remain, and shall be integrated into new plant master controller, for indication.
  - 1. Existing RTD system measuring temperature at four points: feedwater in and out, flue gas in and out.
- G. 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 future 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 existing sensors mounted on storage tanks.
  - b. High and Low Steam Header Pressure (2 functions): Actuated by existing adjustable automatic reset UL listed pressure switches.
  - c. Emergency Gas Valve Closed: Actuated by existing 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 existing oil tank level monitor system.
  - e. Low Excess Air – Boiler (1 function per boiler): Actuated by existing flue gas oxygen analyzers. Refer to Paragraph, AUTOMATIC BOILER AND BURNER CONTROL SYSTEMS.
  - f. High Natural Gas Header Pressure: Actuated by existing pressure switch connected to gas header.
  - g. LP Igniter (Pilot) Gas in Use – For Emergency Only: Actuated by existing high pressure switch mounted on LPG header.
  - h. Fuel Oil Temperature – High and Low (Heated Oil Only): Actuated by existing temperature switches located on the fuel oil header.
  - i. Low feedwater pressure (1 function per header): Actuated by existing pressure switches on feedwater headers.

- j. Input/Output (I/O) Modules: Provide 20% (2 minimum) installed spare I/O of each type for future computer data acquisition system.
- H. Emergency Fuel Safety Shut-Off Valve Control: Manual shutoff switches are existing to remain. 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 turned off.
- I. Provide Remote Registers for Fuel Meters.
- J. Clock: existing to remain.
- K. Nameplates: Provide engraved plastic laminated nameplates for all devices on front of all panels. 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.
- L. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- M. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- N. 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 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
  - 4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.
- O. Spare Parts Required:
  - Lamps: Six of each type in panel and instruments.
  - Touch-up paint for panel: One pint.

### **2.3 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: existing to remain.
- D. Boiler Control Stations or Touch Screens: See Paragraph, AUTOMATIC BOILER CONTROL SYSTEMS.
- E. Draft Gages: existing to remain, mounted in main panel.
- 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.

**2.4 COMPUTER WORK STATION AND PROGRAMMING:**

- A. The individual boiler plant controllers and instrumentation system shall have the capability of being networked with a future 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 in the future 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.

**2.5 FLUE GAS OXYGEN ANALYZERS (EXISTING TO REMAIN, INCLUDED HERE FOR PURPOSES OF NEW COMBUSTION CONTROLLER PROGRAMMING/CONFIGURATION):**

- A. Oxygen content of flue gases of each boiler measured by existing systems with probe mounted in stack or breeching. Output to boiler/burner submaster controller for oxygen trim
- B. Analyzer Outputs:
1. Existing analyzer has 4-20 mA analog output.
  2. 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.

**2.6 FLOW METERS: ALL REQUIRED ARE EXISTING TO REMAIN.**

**2.7 PRESSURE SENSORS AND TRANSMITTERS: ALL REQUIRED ARE EXISTING TO REMAIN.**

**2.8 BOILER DRAFT GAGES: ALL REQUIRED ARE EXISTING TO REMAIN.**

**2.9 TEMPERATURE SENSORS AND TRANSMITTERS: ALL REQUIRED ARE EXISTING TO REMAIN.**

**2.10 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 Contracting Officer's Representative (COR).

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 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. All sensors and transmitters for each recorder input are existing to remain.
4. All data shall be available via Modbus communications for integration into future computer workstation.

## **2.11 TOOLS:**

- A. 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 Contracting Officer's Representative (COR).

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS:**

- A. General:
  1. Nameplates, Labels and Identification: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC, BOILER PLANT, 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; and Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. 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. 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.

C. 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.

**3.2 TESTING, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS,:**

- A. Representatives of the designer of the system shall demonstrate proper operation and calibration of all components, computer programs, and entire systems to the Contracting Officer's Representative (COR). 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. Pressure test all pneumatic control tubing at one and one-half times the normal operating pressure.
- C. Testing shall demonstrate the proper operation of all equipment, proper execution of the sequence of operation, proper tuning of control loops and maintaining of all set points.
- D. Document all tests with detailed report of test results. Explain in detail the nature of each failure and corrective action taken.
- E. 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 Contracting Officer's Representative (COR).
- F. Demonstrate safety and operating interlocks.
- G. 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.
- H. Furnish to Contracting Officer's Representative (COR) 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.

- I. 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.
- J. Future Computer Workstation Integration Test:
  - 1. Using laptop PC, test ability of all new controls to properly communicate with future remote computer workstation and operate the control systems.

### **3.3 STARTUP AND TESTING**

- A. An employee of the manufacturer of combustion controls provided shall observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer's Representative (COR) and Boiler Plant Operator. Provide a minimum of 7 days prior notice.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA personnel in operation and maintenance of units, as follows:
  - 1. Provide a minimum of three onsite training classes 4 hours in length during the construction period for personnel designated by the COR.
  - 2. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 4 hrs. in length and must be coordinated with the COR.
  - 3. Train the designated staff of COR to enable them to:
    - a. Day-to-day Operators:
      - 1. Proficiently operate the system
      - 2. Understand control system architecture and configuration
      - 3. Understand DDC system components
      - 4. Understand system operation, including DDC system control and optimizing routines (algorithms)
      - 5. Operate peripherals
      - 6. Log on and off the system
      - 7. Access graphics, point/object reports, and logs
      - 8. Adjust and change system setpoints, time schedules, and holiday schedules
      - 9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
      - 10. Understand system drawings, and Operation and Maintenance manual
      - 11. Understand the job layout and location of control components
      - 12. Access data from DDC controllers
      - 13. Operate portable operator's terminals

- b. Advanced Operators:
  - 1. Make and change graphics on the controller/HMI
  - 2. Create, delete, and modify alarms, including annunciation and routing of these
  - 3. Create, delete, and modify point/object trend logs, and graph or print these
  - 4. Create, delete, and modify reports
  - 5. Add, remove, and modify system's physical points/objects
  - 6. Create, modify, and delete programming
  - 7. Add panels when required
  - 8. Add operator interface stations
  - 9. Create, delete, and modify system displays — both graphical and otherwise
  - 10. Perform DDC system field checkout procedures
  - 11. Perform DDC controller unit operation and maintenance procedures
  - 12. Perform peripheral operation and maintenance procedures
  - 13. Perform DDC system diagnostic procedures
  - 14. Configure hardware including PC boards, switches, communication, and I/O points/objects
  - 15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
  - 16. Adjust, calibrate, and replace system components
- c. System Managers/Administrators:
  - 1. Maintain software and prepare backups
  - 2. Interface with job-specific, third-party operator software
  - 3. Add new users and understand password security procedures
- 4. Submit training plans and instructor qualifications in writing to the Contracting Officer's Representative (COR), a minimum of 6 weeks prior to the scheduled construction completion date, for review and approval. Engineer will modify course outlines and manuals if necessary to meet the Government's needs. Engineer will review and approve course outlines and manuals at least three weeks before first class. The instructor(s) shall provide one copy of training material per student.
- 5. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- 6. Classroom training shall be done using the actual installed hardware.
- B. Provide video with audio of all instructions given orally to VA personnel. Provide four copies of the videos to the COR, in DVD format. DVD shall be divided into segments separating different instruction/training topics and shall have menu interface, to choose a desired topic from a list, so that instructions on a specific topic are able to be quickly referenced by VA boiler plant personnel in the future.
- C. Coordinate all training requirements above, with requirements for instructions specified in Section 23 08 11.

IMPROVE BUILDING AUTOMATION SYSTEM  
VAMC DAYTON, OHIO

INSTRUMENTATION AND CONTROL FOR  
BOILER PLANT 11-10

--- E N D ---

**SECTION 23 09 23**  
**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. A complete new stand-alone direct digital control system shall be provided under this project to serve the new equipment and renovated areas of this project. The system shall be a Direct Digital Control System utilizing electric actuation.
- B. The Contractor administered by this section of the technical specifications must be in the business of installing direct digital controls for over three (3) years and must have installed and completed at least ten (10) direct digital temperature control jobs of similar design using the same model of equipment as specified. The Contractor administered by this section of the technical specifications must be a Licensed Factory Representative and Installer of the manufacturer's specified for the local area, and shall have a local engineering and service office within 90 miles of the job site.
- C. The basic control system shall include all sensors, controllers, instruments, valves, actuators, devices, installation and service for a complete and functional control system. All control devices (valves, dampers, actuators, etc.) are included under the controls work unless specifically specified elsewhere in the Specifications. Control system shall be designed to allow easy field adjustment of all setpoints and parameters.
- D. Identify all active or inactive pneumatic tubing, control wiring, equipment, etc., associated with systems in the scope of this project. Remove all pneumatic tubing, control wiring and control devices not required to accommodate the renovated areas and new control system.
- E. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
  - 1. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135 (BACnet), ANSI/EIA/CEA-709 (LONTalk), MODBUS Application Protocol V-1.1b, OPC, and other open and proprietary communication protocols in one open, interoperable system.
  - 2. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135, (BACnet) and ANSI/EIA/CEA-709 (LonMark) to assure interoperability between all system components is required. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.

3. The supplied system shall incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the existing server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
  4. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
  5. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.
  6. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
  7. The control system shall accommodate one (1) Engineering Control Center and the control system shall accommodate multiple web-based Users simultaneously, and the access to the system shall be limited only by operator password.
- F. Some products are furnished but not installed by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors, formal acknowledgements in writing prior to submission, the installation of the products. These products may include but are not limited to the following:
1. Control valves.
  2. Flow switches.
  3. Flow meters.
  4. Sensor wells and sockets in piping.
  5. Terminal unit controllers.



G. Some products are installed but not furnished by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors, formal acknowledgements in writing prior to submission, the procurement of the products. These products may include but are not limited to the following:

1. Factory-furnished accessory thermostats and sensors furnished with unitary equipment.

H. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors, formal acknowledgements in writing prior to submission, the particulars of the products. These products may include but are not limited to the following:

1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.

2. Chiller controls.

3. Terminal units' velocity sensors

4. Variable frequency drives.

I. Responsibility Table:

<b>Work/Item/System</b>	<b>Furnish</b>	<b>Install</b>	<b>Low Voltage Wiring</b>	<b>Line Power</b>
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
Terminal units	23	23	N/A	26
Controllers for terminal units	23 09 23	23	23 09 23	26
LAN conduits & cabling	23 09 23	23 09 23	23 09 23	N/A
Automatic dampers (not furnished with equipment)	23 09 23	23	N/A	N/A
Automatic damper actuators	23 09 23	23 09 23	23 09 23	23 09 23
Manual valves	23	23	N/A	N/A
Automatic valves	23 09 23	23	23 09 23	23 09 23
Pipe insertion devices and taps, flow and pressure stations.	23	23	N/A	N/A
Thermowells	23 09 23	23	N/A	N/A
Current Switches	23 09 23	23 09 23	23 09 23	N/A
Control Relays	23 09 23	23 09 23	23 09 23	N/A
Interface with chiller controls	23 09 23	23 09 23	23 09 23	26

<b>Work/Item/System</b>	<b>Furnish</b>	<b>Install</b>	<b>Low Voltage Wiring</b>	<b>Line Power</b>
Chiller controls interface with control system	23	23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Smoke detectors	28 31 00	28 31 00	28 31 00	28 31 00
Fire/Smoke Dampers	23	23	28 31 00	28 31 00
Smoke Dampers	23	23	28 31 00	28 31 00
Fire Dampers	23	23	N/A	N/A
Chiller/starter interlock wiring	N/A	N/A	26	26
Chiller Flow Switches	23	23	23	N/A
VFDs	26	26	23 09 23	26
Fire Alarm shutdown relay interlock wiring	28	28	28	26
Fan Coil Unit controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Unit Heater controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Starters, HOA switches	26	26	N/A	26

- J. This facility's existing direct-digital control system is Tridium-based, and its ECC is located in Building 310, 4<sup>th</sup> floor mechanical mezzanine office – refer to floor plans for location. The existing system's top-end communications is via Ethernet IP. The existing system's ECC and top-end controllers were installed in 2010. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.
- K. Unitary standalone systems including Unit Heaters, Cabinet Unit Heaters, Fan Coil Units, Base Board Heaters, thermal comfort ventilation fans, and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents. Application of standalone unitary controls is limited to at least those systems wherein remote monitoring, alarm and start-up are not necessary. Examples of such systems include:
1. Light-switch-operated toilet exhaust
  2. Vestibule heater
  3. Exterior stair heater
  4. Attic heating and ventilation

5. Mechanical or electrical room heating and ventilation.

- L. The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system.  
Use electricity as the motive force for all damper and valve actuators.

## **1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- E. Section 27 15 00, COMMUNICATIONS HORIZONTAL CABLING

## **1.3 DEFINITIONS**

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; a prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- B. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc).
- D. BACnet: A Data Communication Protocol for Building Automation and Control Networks, ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.
- E. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.
- F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may use different LAN technologies.
- G. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
- H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- I. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.
- J. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.
- K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

- L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- M. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- N. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- O. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- P. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls
- Q. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- R. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- S. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.
- T. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.
- U. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- V. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- W. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the

subsystems shall be capable of operating in a stand-alone mode using the last best available data.

- X. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- Y. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Z. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- AA. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- BB. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- CC. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- DD. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- EE. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
- FF. GIF: Abbreviation of Graphic interchange format.
- GG. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- HH. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- II. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI), digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- JJ. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to "sockets" without confirmation of receipt. Transmission

Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

- KK. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- LL. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- MM. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- NN. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VA health-care facilities. It uses twisted-pair wiring for relatively low speed and low cost communication.
- OO. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
- PP. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
- QQ. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- RR. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.
- SS. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
- TT. Operating system (OS): Software, which controls the execution of computer application programs.
- UU. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- VV. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- WW. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.
- XX. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.
- YY. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.

- ZZ. Repeater: A network component that connects two or more physical segments at the physical layer.
- AAA. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.
- BBB. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.
- CCC. Thermostats: devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

#### **1.4 QUALITY ASSURANCE**

A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.
2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 90 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in

order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.
2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

## 1.5 PERFORMANCE

A. The system shall conform to the following:

1. Graphic Display: The system shall display up to four (4) graphics on a single screen with a minimum of twenty (20) dynamic points per graphic. All current data shall be displayed within ten (10) seconds of the request.
2. Graphic Refresh: The system shall update all dynamic points with current data within eight (8) seconds. Data refresh shall be automatic, without operator intervention.
3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be two (2) seconds. Analog objects shall start to adjust within two (2) seconds.
4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior six (6) seconds.
5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within five (5) seconds of each other.
8. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
9. Reporting Accuracy: Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	$\pm 0.5^{\circ}\text{C}$ ( $\pm 1^{\circ}\text{F}$ )
Ducted air temperature	$\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ]
Outdoor air temperature	$\pm 1.0^{\circ}\text{C}$ [ $\pm 2^{\circ}\text{F}$ ]



Water temperature	$\pm 0.5^{\circ}\text{C}$ [ $\pm 1^{\circ}\text{F}$ ]
Relative humidity	$\pm 2\%$ RH
Water flow	$\pm 1\%$ of reading
Air flow (terminal)	$\pm 10\%$ of reading
Air flow (measuring stations)	$\pm 5\%$ of reading
Air pressure (ducts)	$\pm 25$ Pa [ $\pm 0.1$ "w.c.]
Air pressure (space)	$\pm 0.3$ Pa [ $\pm 0.001$ "w.c.]
Water pressure	$\pm 2\%$ of full scale *Note 1
Electrical Power	$\pm 0.5\%$ of reading

Note 1: for both absolute and differential pressure

10. Control stability and accuracy: Control sequences shall maintain measured variable at setpoint within the following tolerances:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	$\pm 50$ Pa ( $\pm 0.2$ in. w.g.)	0–1.5 kPa (0–6 in. w.g.)
Air Pressure	$\pm 3$ Pa ( $\pm 0.01$ in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	$\pm 10\%$ of full scale	
Space Temperature	$\pm 1.0^{\circ}\text{C}$ ( $\pm 2.0^{\circ}\text{F}$ )	
Duct Temperature	$\pm 1.5^{\circ}\text{C}$ ( $\pm 3^{\circ}\text{F}$ )	
Humidity	$\pm 5\%$ RH	
Fluid Pressure	$\pm 10$ kPa ( $\pm 1.5$ psi)	0–1 MPa (1–150 psi)
Fluid Pressure	$\pm 250$ Pa ( $\pm 1.0$ in. w.g.)	0–12.5 kPa (0–50 in. w.g.) differential

11. Extent of direct digital control: control design shall allow for at least the points indicated on the points lists on the drawings.

## 1.6 WARRANTY

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the government. 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 connect via (through password-limited access) VPN through the internet monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after

business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.

- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VA.

## **1.7 SUBMITTALS**

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature, pressure, flow and humidity sensors and transmitters.
  2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
  3. Control dampers and control valves schedule, including the size and pressure drop.
  4. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawings that it supposed to represent.
  5. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
  6. Color prints of proposed graphics with a list of points for display.
  7. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
  8. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  9. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

10. Riser diagrams of wiring between central control unit and all control panels.
  11. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.
  12. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.
  13. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- D. Licenses: Provide open licenses for all software residing on and used by the Controls Systems and transfer these open licenses to the VA prior to completion.
- E. 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.
- F. Operation and Maintenance (O/M) Manuals):
1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
  2. Include the following documentation:
    - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
    - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
    - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
    - d. Complete troubleshooting procedures and guidelines for all systems.
    - e. Complete operating instructions for all systems.
    - f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
    - g. Training Manuals: Submit the course outline and training material to the COR for approval six (6) weeks prior to the training of VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including

programming. The COR reserves the right to modify any or all of the course outline and training material.

h. Licenses, guaranty, and other pertaining documents for all equipment and systems.

G. Submit Performance Report to COR 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 per Paragraph 3.3 below. Contractor shall also record instruction sessions as noted below. First Phase: Formal instructions to the VA facilities personnel for a total of 8 hours, given in multiple training sessions (each no longer than four hours in length), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the COR.
- B. 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 shall provide 16 hours of instructions, given in multiple training sessions (each no longer than four hours in length), to the VA facilities personnel.
- C. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor shall review the manual contents with VA facilities personnel during second phase of training.
- D. Training shall be given by direct employees of the controls system subcontractor.

### **1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)**

- A. The peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.
- B. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65°C (-40 to 150°F).
- C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

### **1.10 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):  
Standard 135-08 .....BACNET Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):

B16.18-05.....	Cast Copper Alloy Solder Joint Pressure Fittings.
B16.22-05.....	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

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
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G. National Fire Protection Association (NFPA):

70-08 .....	National Electric Code
90A-09.....	Standard for Installation of Air-Conditioning and Ventilation Systems

H. 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-06.....	Standard for Smoke Dampers
916-07 .....	Energy Management Equipment
1076-05 .....	Proprietary Burglar Alarm Units and Systems

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Spare parts shall be available for at least five years after completion of this contract.

### 2.2 CONTROLS SYSTEM ARCHITECTURE

- A. The Direct Digital Control (DDC) system shall be based on the Niagara<sup>AX</sup> Framework (or "Niagara<sup>AX</sup>"), a Java-based framework developed by Tridium. Systems not developed on the Niagara<sup>AX</sup> Framework platform are unacceptable.

The software licensing shall have no restrictions on which brand of application engine, supervisor or system programming tools can interact with the system. All NiagaraAX software shall have an open license; i.e., shall have the following NiagaraAX Compatibility Statement (NICS): "accept.station.in=\*"; "accept.station.out=\*" and "accept.wb.in:=" and "accept.wb.out=\*".

1. The contractor administered by this section of the technical specifications shall connect all new Building Controllers (BC) and Programmable Equipment Controllers (PEC) to VA local area network as indicated on plans.
  2. Application Specific Controllers (ASC) shall communicate via LonMark/LonTalk and/or BACnet MS/TP communication protocols to Building Controllers (BC) or Programmable Equipment Controllers (PEC).
- B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.
- C. Network Architecture
1. The Controls communication network shall utilize FOX TCP/IP communications protocol operating over a standard Ethernet LAN and operate at a minimum speed of 100 Mb/sec.
  2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations. They may also utilize digital wireless technologies as appropriate to the application and if approved by the VA.
  3. All necessary telephone lines, ISDN lines and Internet Service Provider services and connections will be provided by the VA.
- D. Third Party Interfaces:
1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades.
  2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.
- E. Servers:
1. ECC data storage server(s) to archive historical data including trends, alarm and event histories and transaction logs, are existing to remain.
  2. Server is equipped with the same software tool set that is located in the Building Controllers and Programmable Equipment Controllers for system configuration and custom logic definition and color graphic configuration.
  3. Access to all information on the data storage server(s) shall be through the same browser functionality used to access individual nodes. When logged onto a server the operator shall be able to also interact with any controller on the control system as required for the functional operation of the controls systems.

4. Existing server(s) shall be utilized for controls systems application configuration, for archiving, reporting and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and similar.
5. Existing company logos of controls contractors shall be removed from all ECC graphics. Graphics for systems integrated to existing ECC shall be upgraded under this contract as follows, to provide floor plan graphics for each building:
  - a. For existing systems with floor plan graphics provided: All existing floor plan background files shall be replaced with new, to standardize appearance across entire ECC.
  - b. For existing systems without floor plan graphics provided: Provide floor plan graphics. Existing building equipment summary graphics (i.e. table of values, etc.) for these systems shall remain.
  - c. For all existing DDC control systems integrated to Niagara AX head-end: Provide floor plan graphics for all floors of all buildings where any existing DDC system component is located (control device, sensor, DDC-controlled equipment, DDC control panels, etc.), to show location of component within building. Entire extents of each floor plan, whether overall floor plan or larger scale floor plan of smaller area of building, shall be viewable on a single screen without scrolling. Overall floor plan of each floor for all included buildings shall be displayed. In cases where the building is too large to legibly show zone information/equipment locations on the overall floor plan, floor plan shall be subdivided into smaller areas at a larger scale to eliminate congestion on the screen, so that pertinent information (room identification data, control setpoints and current values, etc.) are easily readable. Larger scale floor plan graphics shall be linked from overall floor plan, to “drill down” to desired area of building. Floor plan graphics shall show all alarms with color or other visual indicator, and shall indicate thermal comfort conditions on each floor, using dynamic colors to represent zone temperature relative to setpoint (i.e. green if within setpoint range, red if out of setpoint range). Point/object information on floor plans shall dynamically update. Floor plan graphics shall graphically indicate control zoning areas (rooms served by each piece of terminal equipment). Obtain floor plan CAD files during construction, from engineer of record – provide a minimum of 14 days notice in advance of anticipated need for files. CAD file floor plans provided by engineer will include room identification data (names and/or numbers), which shall be displayed for room identification by VA maintenance personnel. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Intent is not to provide additional information that is not already transmitted to and available through ECC, but to show location of control components within building, show zoning, and visually summarize alarms and anomalies within the system on a building floor plan. All

equipment graphics for existing systems integrated to Niagara AX head-end are acceptable, and shall remain.

- d. To assist in bidding graphics upgrade scope, approximate quantities for existing DDC-controlled equipment and required floor plans in applicable buildings are as follows (note: equipment graphics are existing to remain, quantities here are included for reference in regard to setting up floor plan graphics showing equipment location and summary values. List is not all-inclusive, additional floor plans and equipment shall be included in scope of work, even if missing from this list):

B127: 4 AHUs, 12 zone terminal units [floor plans required: basement, 1<sup>st</sup>]

B143: 5 rooftop AHUs, 2 exhaust fans, 2 unit heaters [floor plans required: 1<sup>st</sup>, 2<sup>nd</sup>, roof]

B305: 6 AHUs, 3 zones, 1 chilled water system [floor plans required: basement, 1<sup>st</sup>, 2<sup>nd</sup>, roof]

B310: 8 AHUs, 12 zone terminal units, 1 chilled water system, 1 heating hot water system [floor plans required: 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> (mezzanine), roof]

B315: 2 AHUs, 61 zone terminal units, 1 chilled water system, 1 heating hot water system [floor plans required: ground, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, roof]

B322: 2 AHUs, 12 zone terminal units [floor plans required: 1<sup>st</sup>, roof]

B330: 23 AHUs, 117 terminal units, 6 chillers, 4 cooling towers, 4 secondary chilled water pumps, heating hot water system, 8 domestic water heaters, elevator sump alarm, 3 refrigerator alarms, 3 exhaust fans, pneumatic control air pressure, 3 chilled water differential pressure sensors, 3 heating hot water differential pressure sensors, fume hood alarm, fire pump, jockey pump [floor plans required: basement through 10<sup>th</sup> floors, roof].

B320: 2 AHUs, 63 fan coil units, chilled water system, 25 radiant panels, 9 exhaust fans, 2 fin tube [floor plans required: Pod A 1<sup>st</sup>]

B340: 1 AHU, 34 zone terminal units, 6 exhaust fans, heating hot water system [floor plans required: 1<sup>st</sup>, 2<sup>nd</sup>]

B341: 1 AHU, 33 zone terminal units, 4 exhaust fans, heating hot water system, 2 unit heaters [floor plans required: 1<sup>st</sup>, roof]

B409: 3 AHUs, 60 zone terminal units [floor plans required: basement, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, attic]

## 2.3 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a FOX TCP/IP internetwork.
1. The Data link / physical layer protocol (for communication) acceptable to the VA throughout its facilities is Ethernet (ISO 8802-3).
- B. Each controller shall have a communication port for connection to an operator interface.



- C. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
- D. New systems shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.
- E. Controllers with real-time clocks shall use the Niagara AX Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

## **2.4 NETWORK AND DEVICE NAMING CONVENTION**

- A. Network Numbers
  - 1. Network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VA campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building.
  - 2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:
    - a. FFF = Facility code (see below)
    - b. NN = 00-99 This allows up to 100 networks per facility or building
- B. Device Instances
  - 1. . Using Agency's unique device instances are formed as follows: "Dev #" = "FFFNDD" where
    - a. FFF and N are as above and
    - b. DD = 00-99, this allows up to 100 devices per network.
  - 2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
  - 3. Facility code assignments:
  - 4. 000-400 Building/facility number

5. Note that some facilities have a facility code with an alphabetic suffix to denote wings, related structures, etc. The suffix will be ignored. Network numbers for facility codes above 400 will be assigned in the range 000-399.

C. Device Names

1. Name the control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. The intent of the device naming is to be easily recognized. Names can be up to 254 characters in length, without embedded spaces. Provide the shortest descriptive, but unambiguous, name. For example, in building #123 prefix the number with a "B" followed by the building number, if there is only one chilled water pump "CHWP-1", a valid name would be "B123.CHWP. 1.STARTSTOP". If there are two pumps designated "CHWP-1", one in a basement mechanical room (Room 0001) and one in a penthouse mechanical room (Room PH01), the names could be "B123.R0001.CHWP.1. STARTSTOP" or "B123.RPH01.CHWP.1.STARTSTOP". In the case of unitary controllers, for example a VAV box controller, a name might be "B123.R101.VAV". These names should be used for the value of the "Object\_Name" property of the controllers involved so that the controller name and the EMCS name are the same.

## 2.5 BUILDING CONTROLLERS

- A. All Building Controllers shall be Niagara<sup>AX</sup> based Jace-600's.
- B. The DDC system contractor shall supply one or more Building Controllers (BC) as indicated on the plans.
- C. The Building Controller (BC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the BC. It shall be capable of executing application control programs to provide:
  1. Calendar functions
  2. Scheduling
  3. Trending
  4. Alarm monitoring and routing
  5. Time synchronization
  6. Integration of controller data through NiagaraAX drivers installed in the ECC.
  7. Network Management functions for all controllers
- D. The Building Controller (BC) shall provide the following hardware features as a minimum:
  1. One Ethernet Port – 10/100 Mbps
  2. One LonWorks Interface Port – 78KB FTT-10A
  3. One RS-485 Port
  4. Battery Backup
  5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with minimum 1 gigabyte storage capacity)

6. The BC shall be capable of operation over a temperature range of 32 to 122°F
7. The BC shall be capable of withstanding storage temperatures of between 0 and 158°F
8. The BC shall be capable of operation over a humidity range of 5 to 95% RH, non-condensing
- E. The BC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the BC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- F. The BC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- G. Event Alarm Notification and actions
  1. The BC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  2. The BC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
  3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
    - a. To alarm
    - b. Return to normal
    - c. To fault
  4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
  5. Provide timed (schedule) routing of alarms by class, object, group, or node.
  6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- H. Control equipment and network failures shall be treated as alarms and annunciated.
- I. Alarms shall be annunciated in any of the following manners as defined by the user:
  1. Screen message text
  2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
    - a. Day of week
    - b. Time of day
    - c. Recipient
  3. Pagers via paging services that initiate a page on receipt of email message
  4. Graphic with flashing alarm object(s)
- J. The following shall be recorded by the BC for each alarm (at a minimum):
  1. Time and date

2. Location (building, floor, zone, office number, etc.)
  3. Equipment (air handler #, accessway, etc.)
  4. Acknowledge time, date, and user who issued acknowledgement.
  5. Number of occurrences since last acknowledgement.
- K. Alarm actions shall have the ability to be initiated by user defined programmable objects created for that purpose.
- L. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
- M. A log of all alarms shall be maintained by the ECC and shall be available for review by the user.
- N. Provide a "query" feature to allow review of specific alarms by user defined parameters.
- O. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- P. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- Q. Data Collection and Storage
1. The BC shall have the ability to collect data for any property of any object and store this data for future use.
  2. The data collection shall be performed by log objects, resident in the BC that shall have, at a minimum, the following configurable properties:
    - a. Designating the log as interval or deviation.
    - b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
    - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, shall initiate logging of the object.
    - d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
    - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
  3. All log data shall be stored in a relational database at the ECC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
  4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
  5. All log data shall be available to the user in the following data formats:
    - a. HTML
    - b. XML
    - c. Plain Text

- d. Comma or tab separated values
- 6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- 7. The BC shall have the ability to archive its log data either locally (to itself), or remotely to a server or ECC on the network. Provide the ability to configure the following archiving properties, at a minimum:
  - a. Archive on time of day
  - b. Archive on user-defined number of data stores in the log (buffer size)
  - c. Archive when log has reached its user-defined capacity of data stores
  - d. Provide ability to clear logs once archived
- R. Audit Log
  - 1. Provide and maintain an Audit Log that tracks all activities performed at the ECC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (at the ECC), or to a server. For each log entry, provide the following data:
    - a. Time and date
    - b. User ID
    - c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- S. Database Backup and Storage
  - 1. The BC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
  - 2. Copies of the current database and the most recently saved database shall be stored in the BC. The age of the most recently saved database is dependent on the user-defined database save interval.
  - 3. The BC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
- T. Graphical User Interface Software
  - 1. Operating System:
  - 2. The GUI shall run on Microsoft Windows XP Professional.
  - 3. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

4. Real-Time Displays: The GUI, shall at a minimum, support the following graphical features and functions:
  - a. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
  - b. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
  - c. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
  - d. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
    1. Schedule times shall be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    2. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
  - e. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
  - f. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
5. System Configuration: At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
  - Create, delete or modify control strategies.
  - Add/delete objects to the system.
  - Tune control loops through the adjustment of control loop parameters.
  - Enable or disable control strategies.
  - Generate hard copy records or control strategies on a printer.
  - Select points to be alarmable and define the alarm state.
  - Select points to be trended over a period of time and initiate the recording of values automatically.
6. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be

available through the use of hypertext. All system documentation and help files shall be in HTML format.

7. Security: Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.
8. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
9. Alarm Console:
  - a. The system shall be provided with a dedicated alarm window or console. This window shall notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console shall have the ability to be enabled or disabled by the system administrator.
  - b. When the Alarm Console is enabled, a separate alarm notification window shall supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window shall notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

## **2.6 PROGRAMMABLE EQUIPMENT CONTROLLERS (PEC)**

- A. All PEC controllers shall be Niagara<sup>AX</sup> based Jace-200's or Jace-600's. BACNet or LON based PEC's requiring manufacturer specific engineering/programming software tool are not acceptable.
- B. Controls shall be microprocessor based Interoperable Niagara<sup>AX</sup> Programmable Equipment Controllers (PEC) in accordance with the JSR-60 Baja Specification. PEC's shall be provided for applications as shown on the drawings. The application control program shall be resident within the same enclosure as the discrete input/output circuitry, which translates the sensor and actuator signals; the PEC shall communicate serially using standard protocols with control devices of the equipment that it is controlling. The system supplier shall provide a NICS document showing the installed system's compliance level to the Software Licensing Agreement of this specification.
- C. The PECs shall communicate using FOX communication protocol with the BC(s) via an Ethernet connection at a baud rate of not less than 10 Mbps.

- D. All PEC's shall be fully application programmable. Controllers require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
- E. Each major HVAC system (air handling unit, chilled water system, hot water system, etc.) shall have its own stand-alone PEC DDC controller. Control of a major HVAC system shall not be split between multiple PEC controllers. If a large HVAC system exceeds the point capacity of one PEC then monitor only points shall be connected to a separate PEC or IO module.
- F. The DDC system contractor shall provide documentation for each PEC, with the following information at a minimum:
  - 1. IP and MAC address, name, type and HostID
  - 2. Niagara Objects; name, type and instance number
- G. The supplier of any programmable Niagara PEC shall ensure that the proper Niagara objects are provided in each PEC, as required by the points list shown on the drawings.

## **2.7 DIRECT DIGITAL CONTROLLER APPLICATION SOFTWARE**

- A. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the associated system digital controllers. Editing of the application shall occur at the ECC or via a portable operator's terminal, when it is necessary, to access directly the programmable unit.
  - 1. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoor air dampers. If the outdoor air dry bulb temperature and humidity fall below changeover set point the energy control center shall modulate the dampers to provide 100 percent outdoor air. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any time.
  - 2. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation. The control system shall have the ability for Night Setback/Morning Warmup; however, the controls shall be set up for 24/7 occupied operation.
  - 3. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall consider both outside weather conditions and inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. The program shall poll all zones served by the associated AHU and shall select the warmest



- and coolest zones. These shall be used in the start time calculation. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via the ECC. The control system shall have the ability for optimum start/stop; however, the controls shall be set up for 24/7 occupied operation.
4. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

## **2.8 SENSORS (AIR, WATER AND STEAM)**

- A. Sensors' measurements shall be read back to the DDC system, and shall be visible by the ECC.
- B. Temperature and Humidity Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
1. Temperature Sensors: thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
- a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
- b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
- c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on sensor cover, and communication port. Match room thermostats. Provide a tooled-access cover.
- 1) Public space sensor: setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Do not provide in-space User set-point adjustment. Provide an opaque keyed-entry cover if needed to restrict in-space User set-point adjustment.
- d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
- e. Room security sensors shall have stainless steel cover plate with insulated back and security screws.
- f. Wire: Twisted, shielded-pair cable.

- g. Output Signal: 4-20 ma.
- 2. Humidity Sensors: Bulk polymer sensing element type.
  - a. Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability.
  - b. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - c. 4-20 ma continuous output signal.
- 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.
- D. 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.
- E. 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.

## 2.9 CONTROL CABLES

- A. General:
  - 1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
  - 2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
  - 3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
  - 4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
  - 5. Label system's cables on each end. Test and certify cables in writing to the COR before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts,

cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the COR. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.

6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.
- B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 19.
- C. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

## **2.10 THERMOSTATS AND HUMIDISTATS**

- A. Room thermostats controlling unitary standalone heating and cooling devices not connected to the DDC system shall have three modes of operation (heating - null or dead band - cooling). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats shall have manufacturer's recommended finish, setpoint range and temperature display and external adjustment:
  1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.
    - a. Public Space Thermostat: Public space thermostat shall have a thermistor sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.
    - b. Patient Room Thermostats: thermistor with in-space User set point adjustment and an on-casing room temperature numerical temperature display.
    - 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. Freezestats shall be manually-reset.

## 2.11 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: Outside air and relief air dampers shall be insulated and thermally broken with an air leakage rating not to exceed 4.5 cfm/sq. ft. at 4" differential static pressure. Return air and other control dampers leakage rate shall not exceed 10.5 cfm/sq. ft. at 4" differential static pressure.
  - 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 with neoprene, felt, or rubber as required to meet leakage criteria.
  - 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.
  - 6. Shafts: Galvanized steel.
  - 7. Maximum air velocity and pressure drop through free area of the fully open dampers:
    - a. Smoke damper in air handling unit: 305 meter per minute (1000 fpm).
    - b. Duct mounted damper: 600 meter per minute (2000 fpm).
    - c. Maximum static pressure loss: 50 Pascal (0.20 inches water gage).
- D. 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.
- E. Control Valves:
  - 1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
  - 2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
  - 3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
  - 4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
  - 5. Flow characteristics:

- a. Three way modulating valves shall be globe pattern. Position versus flow relation shall be linear relation for steam or equal percentage for water flow control.
    - b. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
    - c. Two-way 2-position valves shall be ball, gate or butterfly type.
  6. Maximum pressure drop:
    - a. Two position steam control: 20 percent of inlet gauge pressure.
    - b. Modulating Steam Control: 80 percent of inlet gauge pressure for 15 psi or less; 50 percent of inlet gauge pressures for greater than 15 psi. (acoustic velocity limitation).
    - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
  7. Two position water valves shall be line size.
- F. Damper and Valve Operators and Relays:
1. Electric operator shall provide full modulating control of dampers and valves. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
    - a. Minimum valve closeoff pressure shall be equal to the system pump's dead-head pressure, minimum 50 psig for valves smaller than 4 inches.
  2. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
    - a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
  3. Damper actuators shall be externally mounted on standoffs where required, to provide complete insulation coverage.
  4. See drawings for required control operation.

## 2.12 AIR FLOW CONTROL

- A. Airflow and static pressure shall be controlled via digital controllers with inputs from airflow control measuring stations and static pressure inputs as specified. Controller outputs shall be analog or pulse width modulating output signals. The controllers shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.
- A. 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. Fan Inlet Air Flow Measuring Stations:
    - a. Fan inlet airflow measuring stations for installation at supply and return fan inlets shall include flow transducers with minimum .50% full-scale accuracy signal processors. The

minimum accuracy shall be 2% of reading or better thru a velocity range of 500-8000 fpm.

4. 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 24 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems. The electronic panel shall have the capability to accept user defined scaling parameters for all output signals.
  - c. Electronics Panel shall have the capability to digitally display airflow in CFM and temperature in degrees F. The displays shall be provided as an integral part of the electronics panel. The electronic panel shall have the capability to totalize the output flow in CFM for two or more systems, as required. A single output signal may be provided which will equal the sum of the systems totalized. Output signals shall be provided for temperature and airflow. Provide remote mounted air flow or temperature displays where indicated on the plans.
  - d. Electronics Panel shall have the following:
    - 1) Minimum of 12-bit A/D conversion.
    - 2) Field adjustable digital primary output offset and gain.
    - 3) Airflow analog output scaling of 100 to 10,000 FPM.
    - 4) Temperature analog output scaling from -45°C to 70°C (-50°F to 160°F).
    - 5) Analog output resolution (full scale output) of 0.025%.
  - e. All readings shall be in I.P. units.
5. Thermal flow sensors and its electronics shall be installed as per manufacturer's instructions. The probe sensor density shall be as follows:

Probe Sensor Density	
Area (sq.ft.)	Qty. Sensors
<=1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

- a. Complete installation shall not exhibit more than  $\pm 2.0\%$  error in airflow measurement output for variations in the angle of flow of up to 10 percent in any direction from its calibrated orientation. Repeatability of readings shall be within  $\pm 0.25\%$ .

- C. Vortex type airflow measuring stations may be submitted for project-specific review by the engineer, as an alternative to electronic thermal type.
- D. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:
  - 1. Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
  - 2. For systems with multiple major trunk supply ducts, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the controller.
  - 3. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
  - 4. In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually-reset.
- E. Airflow Synchronization:
  - 1. Systems shall consist of an air flow measuring station for each supply and return duct, the CU and such relays, as required to provide a complete functional system that will maintain a constant flow rate difference between supply and return air to an accuracy of  $\pm 10\%$ . In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representation of total flow.
  - 2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General:
  - 1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to COR for resolution before proceeding with installation.
  - 2. Work Coordination: As described in the 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. Electrical Wiring Installation:

1. All line voltage wiring and low voltage wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling; these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 19. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, COMMUNICATIONS HORIZONTAL CABLING.
3. Install conduit and wiring between digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
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.
- C. Install Sensors and Controls:
- 1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.
    - c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
    - d. Install room sensors permanently supported on wall frame. They shall be mounted at 46" above the finished floor, to comply with ADA requirements.
    - e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors from contact with metal casings and coils using insulated standoffs.
    - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
    - g. All pipe mounted temperature sensors shall be installed in wells.
    - h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
    - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
  - 2. Pressure Sensors:
    - a. Install duct static pressure sensor tips facing directly downstream of airflow.

- b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
  - c. Install snubbers and isolation valves on steam pressure sensing devices.
- 3. Actuators:
  - a. Mount and link damper and valve actuators according to manufacturer's written instructions.
  - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
  - c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
- 4. Flow Switches:
  - a. Install flow switch according to manufacturer's written instructions.
  - b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.
- D. Installation of network:
  - 1. Ethernet:
    - a. The network 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.
  - 2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.
- E. Installation of digital controllers and programming:
  - 1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature can 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, air handling unit, fan, terminal unit, 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 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 COR 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 shall be demonstrated by the installer in the presence of the COR or other VA representative on random samples of equipment as dictated by the COR or other VA representative. Should random sampling indicate improper commissioning, the COR reserves the right to subsequently witness complete calibration of the system at no additional cost to the Government.
  2. Demonstrate to the COR or other VA representative that all required safeties and life safety functions are fully functional and complete.
  3. Make accessible, personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
  4. The following witnessed demonstrations of field control equipment shall be included:
    - a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
    - b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
    - c. Demonstrate the software ability to edit the control program off-line.

- d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location.
- e. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
- f. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
- g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
- h. Prepare and deliver to the COR graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.
- i. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.

### **3.3 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA personnel in operation and maintenance of units, as follows:
  - 1. Provide onsite training classes during the construction period for personnel designated by the COR. Total training time required, as well as maximum length of time per session, shall be as defined in Paragraph 1.8 above.
  - 2. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 4 hrs. in length and must be coordinated with the COR.
  - 3. Train the designated staff of COR to enable them to:
    - a. Day-to-day Operators:
      - 1. Proficiently operate the system
      - 2. Understand control system architecture and configuration
      - 3. Understand DDC system components
      - 4. Understand system operation, including DDC system control and optimizing routines (algorithms)
      - 5. Operate the workstation and peripherals
      - 6. Log on and off the system
      - 7. Access graphics, point/object reports, and logs
      - 8. Adjust and change system setpoints, time schedules, and holiday schedules
      - 9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
      - 10. Understand system drawings, and Operation and Maintenance manual
      - 11. Understand the job layout and location of control components

12. Access data from DDC controllers
13. Operate portable operator's terminals
- b. Advanced Operators:
  1. Make and change graphics on the controller/HMI
  2. Create, delete, and modify alarms, including annunciation and routing of these
  3. Create, delete, and modify point/object trend logs, and graph or print these
  4. Create, delete, and modify reports
  5. Add, remove, and modify system's physical points/objects
  6. Create, modify, and delete programming
  7. Add panels when required
  8. Add operator interface stations
  9. Create, delete, and modify system displays — both graphical and otherwise
  10. Perform DDC system field checkout procedures
  11. Perform DDC controller unit operation and maintenance procedures
  12. Perform workstation and peripheral operation and maintenance procedures
  13. Perform DDC system diagnostic procedures
  14. Configure hardware including PC boards, switches, communication, and I/O points/objects
  15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
  16. Adjust, calibrate, and replace system components
- c. System Managers/Administrators:
  1. Maintain software and prepare backups
  2. Interface with job-specific, third-party operator software
  3. Add new users and understand password security procedures
4. Submit training plans and instructor qualifications in writing to the Contracting Officer's Representative (COR), a minimum of 6 weeks prior to the scheduled construction completion date, for review and approval. Engineer will modify course outlines and manuals if necessary to meet the Government's needs. Engineer will review and approve course outlines and manuals at least three weeks before first class. The instructor(s) shall provide one copy of training material per student.
5. The instructor(s) shall be factory-trained instructors experienced in presenting this material.
6. Classroom training shall be done using the actual installed hardware.
- B. Provide video with audio of all instructions given orally to VA personnel. Provide four copies of the videos to the COR, in DVD format. DVD shall be divided into segments separating different instruction/training topics and shall have menu interface, to choose a desired topic from a list, so that instructions on a specific topic are able to be quickly referenced by VA maintenance personnel in the future.

----- END -----

**SECTION 23 15 00**  
**GENERAL SERVICE COMPRESSED-AIR SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section describes the requirements for DDC controls compressed air systems, including compressors, electric motors and starters, all necessary piping, fittings, valves, gages, switches and all necessary accessories, connections and equipment.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data shall be submitted for the following products:
1. Aboveground Piping
  2. Supporting elements
  3. Valves
  4. Pressure Gages
  5. Air Pressure Reducing and Regulating Valves
  6. Automatic drain valves
  7. Filter capacity and operating characteristics
  8. Vibration Isolation
  9. Air Compressor System:
    - a. Characteristic performance curves.
    - b. Efficiency.
    - c. Compressor; manufacturer and model
    - d. Compressor operating speed
    - e. Capacity; (free air delivered at indicated pressure)
    - f. Type of bearing in compressor
    - g. Type of lubrication
    - h. Unloader; manufacturer, type, and model
    - i. Type and adjustment of drive
    - j. Electrical motor; manufacturer, frame and model
    - k. Speed of motor
    - l. Current characteristics and HP of motor
- C. Hydrostatic, compressed air system, drainage test reports shall be submitted.
- D. Brazing and welding certificates shall be submitted.



#### 1.4 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Standards Institute (ANSI):
  - A13.1- 07 ..... Scheme for the Identification of Piping Systems
  - Bl6.22-01 ..... Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- C. American Society for Testing and Materials (ASTM):
  - B32-04 ..... Standard Specification for Solder Metal
  - B61-08 ..... Standard Specification for Steam or Valve Bronze Castings
  - B62-02 ..... Standard Specification for Composition Bronze or Ounce Metal Castings
  - B88-03 ..... Standard Specification for Seamless Copper Water Tube
- D. National Fire Protection Association (NFPA):
  - 99-2008 ..... Health Care Facilities
- E. American Welding Society (AWS):
  - A5.8-04 ..... Specification for Filler Metals for Brazing and Braze Welding
- F. Manufacturer Standardization of the Valve and Fittings Industry, Inc (MSS):
  - SP-70-06 ..... Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
  - SP-72-99 ..... Standard for Ball Valves With Flanged or Butt Welding For General Purpose
  - SP-110-96 ..... Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

#### 1.5 AS-BUILT DOCUMENTATION

- A. The electronic documentation and copies of the Operations and Maintenance Manual, approved submittals, shop drawings, and other closeout documentation shall be prepared by a computer software program complying with Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C 794d). The manufacturer or vendor of the software used to prepare the electronic documentation shall have a Voluntary Product Accessibility Template made available for review and included as part of the Operations and Maintenance Manual or closeout documentation. All available accessibility functions listed in the Voluntary Accessibility Template shall be enabled in the prepared electronic files. As Adobe Acrobat is a common industry format for such documentation, following the document, "Creating Accessible Adobe PDF files, A Guide for Document Authors" that is maintained and made available by Adobe free of charge is recommended."
- B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

- C. Four sets of operation and maintenance data updated to include submittal review comments shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

## **PART 2 - PRODUCTS**

### **2.1 PIPES, TUBES, AND FITTINGS**

- A. Pipe for general service compressed air system shall be drawn temper, Type "K" or "L" copper tube, conforming to ASTM B88 with wrought copper solder joint fittings conforming to ANSI B16.22.
- B. Copper unions shall conform to ASME B16.22.
- C. Cast copper alloy flanges shall be class 300 conforming to ASME B16.24.
- D. Solder filler metal shall consist of lead free alloys conforming to ASTM B 32 with water flushable flux conforming to ASTM B813.
- E. Silver Brazing Filler metals shall be BCuP series, copper phosphorus alloys for general duty brazing conforming to AWS A5.8.
- F. Pipe identification shall comply with ANSI A13.1.

### **2.2 VALVES**

- A. Ball:
1. Ball valves 80 millimeters or DN80 (3 inches) and smaller shall be full port, two or three piece ball valve conforming to MSS SP-72 and SP-110. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be soldered.
- B. Check:
1. Check valves less than 80 mm or DN80 (3 inches) and smaller shall be class 125, bronze swing check valves with non metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.

### **2.3 DIELECTRIC FITTINGS**

- A. Fittings joining copper alloy and ferrous materials shall be isolated.

- B. Dielectric unions shall be factory fabricated union assemblies, rated at 1725 kPa (250 psig) minimum working pressure at 82 degrees C (180 degrees F) suitable for compressed air service.
- C. Dielectric flanges shall be factory fabricated companion flange assemblies, rated at 2070 kPa (300 psig) minimum working pressure at 82 degrees C (180 degrees F) suitable for compressed air service.

## **2.4 FLEXIBLE PIPE CONNECTORS**

- A. Stainless steel hose flexible connectors shall be corrugated, stainless steel tubing with stainless steel wire braid covering and ends welded to inner tubing. The stainless steel hose connectors shall be rated at 1380 kPa (200 psig) minimum. The end connections for 50 millimeter or DN50 (NPS 2 inches) and smaller shall be threaded steel pipe nipple. The end connections for 65 millimeter or DN65 (NPS 2-1/2 inches and larger) shall be flanged steel nipple.

## **2.5 PRESSURE GAGES FOR COMPRESSED AIR USAGE**

- A. Pressure gages permanently installed in the system or used for testing purposes shall be listed for compressed air service.
- B. ANSI B40.1 all metal case 114 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for compressed air service, and identity labeled. Range shall be 0 to 1375 kPa (0 to 200 psi) gauge.
- C. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.
- D. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psi.
- E. The pointer shall be dark colored metal.
- F. The window shall be glass.
- G. The ring shall be brass or stainless steel.
- H. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.

## **2.6 SPECIALTIES**

- A. AIR PRESSURE REGULATING VALVES
  - 1. Air pressure regulating valves under 80 mm or DN80 (NPS 3 inches) shall be pilot or diaphragm operated, bronze body and trim, direct acting, spring loaded manual pressure setting adjustment and rated for 1380 kPa (200 psig) inlet pressure.
- B. Safety valves shall be constructed according to the ASME Boiler and Pressure Code, Section VIII "Pressure Vessels," and be National Board Certified, labeled, and factory sealed. The safety valve shall be constructed of bronze body with poppet type safety valve for compressed air service.
- C. The automatic drain valves shall have stainless steel body and internal parts rated for 1380 kPa (200 psig) minimum working pressure. The automatic drain valve shall be capable of automatic discharge of collected condensate.

- D. The coalescing filter shall be capable of removing water and oil aerosols, with color change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. The coalescing filter shall including mounting brackets for wall mount application.
- E. Air line lubricators shall come with a drip chamber and sight dome for observing oil drop entering air stream. The air line lubricator shall have oil feed adjustment screw and quick release collar for easy bowl removal. The Air line lubricators shall including mounting brackets for wall mount application.

## **2.7 AIR COMPRESSOR FOR DDC CONTROL AIR SYSTEMS**

- A. The packaged air compressor shall be a factory assembled, wired, piped, and tested that deliver air of quality equal to intake air. The packaged air compressor shall be air cooled, continuous duty. The packaged air compressor shall be capable of operating against a pressure of 690 kPa (100 psig).
- B. The automatic control panel shall house local control and protection functions. The control panel shall comply with NEMA ICS 2 and UL 508. The motor controllers shall be full voltage, combination magnetic type with under-voltage release feature and motor circuit protector type disconnecting means and short circuit protective device. The control voltage shall be 120 volts or less. The motor overload protection shall consist of overload relays in each phase. Starting devices shall consist of Hand-off-Auto selector switch in cover of control panel plus pilot device for automatic control. Automatic alternation of lead and lag compressors shall be through DDC control system, as indicated on drawings. Compressed air system shall include discharge air pressure gage, air filter maintenance indicator, hour meter, compressor discharge air and coolant temperature gages, and control transformer. For connection to alarm system, an alarm signaling device shall annunciate when backup air compressor is operating.
- C. The receiver associated with all new compressors is standalone (remote from compressor units), and is existing to remain.
- D. The packaged air compressor unit shall be secured to a mounting frame strong enough to resist movement due to a seismic event.
- E. The compressor shall be rotary screw type, with a maximum speed of 1400 RPM. The Lubrication system may be automatic flood system or forced feed. A belt guard shall totally enclose all pulleys and shafts.
- F. Motor and Starter: The motor shall be designed to operate to 120 degrees F (48 degrees C) ambient temperature rise type motor, ball bearing, voltage and phase as indicated in schedule and conforming to NEMA standards. The maximum motor speed shall be 1800 RPM. The motor shall be of sufficient size to operate compressor without overloading. Each motor shall include automatic, fully enclosed, magnetic starter, controlled by a (H-O-A) switch. Motors shall be TEFC, with wye-delta start/run.

- G. The in line Filter shall have a Fifty micron element with 23 mL (1/2 pint) safety green transparent bowl. The filter shall be rated at 1025 kPa (150 psig) at 52 °C (125 °F).
- H. The Sound level of the compressor package shall not exceed 68dB (A) when measured in the free field conditions at one meter.
- I. Allowable Vibration Tolerances: 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.

## **2.8 REFRIGERATED TYPE HIGH TEMPERATURE AIR DRYER FOR DDC CONTROL AIR SYSTEMS**

- A. The compressed air dryer shall be a non-cycling, refrigerated, air-cooled, direct expansion type to dehumidify air at the following design conditions:
  - Inlet air temperature: 180 deg. F.
  - Inlet air pressure: 100 PSIG
  - Max. ambient temperature: 100deg. F.
- B. The dryer shall be designed to deliver compressed air with a pressure dew point temperature of 50 deg.F +/- 2 deg.F. Maximum pressure drop shall be 5 PSI or less. Dryer capacity (CFM) shall equal or exceed compressor output flow rate.
- C. The air system shall include individual air to refrigerant heat exchanger, and integrated moisture separator with built zero loss drain.
- D. Heat Exchanger: Hot incoming air shall be cooled to the outlet condition with a compact plate and frame type heat exchanger. The compressed air shall flow in a counter current flow than the refrigerant.
- E. Separator: Centrifugal type, designed to remove 99% of all liquids and solid particle sizes 10 micron and larger. The five step centrifugal separator shall incorporate the following five principles to maximize removal of moisture, emulsion, and particle impurities: 1) Separation through centrifugal force, 2) Velocity reduction, 3) Directional flow change, 4) Impingement on separator bowl, 5) Agglomeration. By gravity, water and contaminants shall be collected at the bottom and removed by the automatic zero loss drain.
- F. Automatic zero loss drain: shall be provided by dryer manufacturer and field-installed external to the separator. This drain ejects condensate as the float level is achieved.
- G. Refrigerant system: shall be completely assembled and factory tested for automatic operation of air dryer. The air dryer shall include a hermetic type refrigerant cooled compressor sized for total dryer capacity, completely wired and piped.  
The refrigerant system shall also include a hot gas bypass valve or fan cycling pressostat, expansion device, and filter drier. System shall be factory tested and shipped with a full refrigerant charge and oil.

- H. Instrument panel shall include refrigerant suction pressure gauge to monitor system operation.
- I. Electrical control panel: shall be constructed to NEMA-1 standards. Electrical controls shall include motor overload protection and on/off switch. Pilot light shall be installed to monitor "power on".
- J. Cabinet: Dryer shall be factory-assembled in a heavy gauge sheet metal cabinet with powder coated paint finish.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Piping shall be installed exposed in mechanical rooms and service areas.
- B. Exposed piping shall be installed at right angles or parallel to building walls. Diagonal runs are prohibited unless indicated.
- C. Piping installed adjacent to equipment shall be located that allows for the required service clearances.
- D. Air and drain piping shall be installed with a 1% slope downward in direction of flow.
- E. Nipples, flanges, unions, transitions, and special fittings, and valves shall be installed with pressure ratings same as or higher than system pressure rating.
- F. Cast copper alloy companion flange with gasket and soldered joints shall be used to connect equipment and specialties with flanged connections.
- G. Flanged joints may be used instead of specified joint for any piping or tubing system.
- H. Only eccentric reducers shall be installed where compressed air piping is reduced in direction of flow, with bottoms of both pipes and reducers fitting flush.
- I. Branch connections shall be installed from the top of the main compressed air line. Drain legs and drain trap shall be installed at the end of each main and branch and at all low points in the system.
- J. Thermometers and pressure gages shall be installed on discharge piping from each air compressor and on each receiver.
- K. Valves shall be installed to permit servicing to all equipment.
- L. Pipes shall be installed free of all sags and bends.
- M. Piping shall be cut square and accurately with a tube cutter (sawing is not permitted) to measurements determined at place of installation and worked into place without springing or forcing the pipe. Tube must bottom in each solder socket so there are no gaps between tube and fitting where solder can enter the inside of line. The tube shall be reamed to remove burrs, being careful not to expand tube and that no chips of copper remain in the line. Care shall be exercised in handling equipment and tools used in cutting or reaming of pipe to prevent oil or grease being introduced into piping.

- N. Particular care shall be exercised, when flux is applied to avoid leaving any excess inside the completed joints. Thoroughly wash the outside of each joint with clean hot water after assembly to remove oxide coating.
- O. Hanger spacing shall be based upon NFPA 99.
- P. Rigidly support valves and other equipment to prevent strain on tube or joints.

### **3.2 TESTS**

Make tests under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of compressors shall be performed simultaneously with the compressed air system of which each compressor is an integral part.

--- E N D ---

**SECTION 26 05 11  
REQUIREMENTS FOR ELECTRICAL INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section applies to all sections of Division 26.
- B. Furnish and install electrical systems, materials, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, conductors and cable, panelboards, and other items and arrangements for the specified items are shown on the drawings.
- C. Conductor ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways sized per NEC. Aluminum conductors are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. The International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), and National Fire Protection Association (NFPA) codes and standards are the minimum requirements for materials and installation.
- B. The drawings and specifications shall govern in those instances where requirements are greater than those stated in the above codes and standards.

**1.3 TEST STANDARDS**

- A. All materials and equipment shall be listed, labeled, or certified by a Nationally Recognized Testing Laboratory (NRTL) to meet Underwriters Laboratories, Inc. (UL), standards where test standards have been established. Materials and equipment which are not covered by UL standards will be accepted, providing that materials and equipment are listed, labeled, certified or otherwise determined to meet the safety requirements of a NRTL. Materials and equipment which no NRTL accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as ANSI, NEMA, and NETA. Evidence of compliance shall include certified test reports and definitive shop drawings.
- B. Definitions:
  - 1. Listed: Materials and equipment 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 materials and equipment or periodic evaluation of services, and whose listing states that the materials and equipment either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
  - 2. Labeled: Materials and equipment 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



materials and equipment, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3. Certified: Materials and equipment which:
  - a. Have been tested and found by a NRTL to meet nationally recognized standards or to be safe for use in a specified manner.
  - b. Are periodically inspected by a NRTL.
  - c. Bear a label, tag, or other record of certification.
4. Nationally Recognized Testing Laboratory: Testing laboratory which is recognized and approved by the Secretary of Labor in accordance with OSHA regulations.

#### **1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)**

- A. Manufacturer's Qualifications: The manufacturer shall regularly and currently produce, as one of the manufacturer's principal products, the materials and equipment specified for this project, and shall have manufactured the materials and equipment for at least three years.
- B. Product Qualification:
  1. Manufacturer's materials and equipment shall have been in satisfactory operation, on three installations of similar size and type as this project, for at least three years.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. Applicable publications listed in all Sections of Division 26 are the latest issue, unless otherwise noted.
- B. Products specified in all sections of Division 26 shall comply with the applicable publications listed in each section.

#### **1.6 MANUFACTURED PRODUCTS**

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, and for which replacement parts shall be available.
- B. When more than one unit of the same class or type of materials and 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 and terminals shall be identified on the equipment being furnished and on all wiring diagrams.

### **1.7 VARIATIONS FROM CONTRACT REQUIREMENTS**

- A. Where the Government or the Contractor requests variations from the contract requirements, 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 MATERIALS AND EQUIPMENT PROTECTION**

- A. Materials and equipment shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
  - 1. Store materials and equipment indoors in clean dry space with uniform temperature to prevent condensation.
  - 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 repaired or replaced, as determined by the COR.
  - 4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  - 5. Damaged paint on equipment 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 shall comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J – General Environmental Controls, OSHA Part 1910 subpart K – Medical and First Aid, and OSHA Part 1910 subpart S – Electrical, 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. Before initiating any work, a job specific work plan must be developed by the Contractor with a peer review conducted and documented by the COR 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.
  - 3. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the COR.

- D. For work that affects existing electrical systems, arrange, phase and perform work to assure minimal interference with normal functioning of the facility. 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 interference.

#### **1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Working clearances shall not be less than specified in the NEC.
- C. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not readily accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
  - 2. "Readily 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 panelboards, cabinets, fused and non-fused safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. Identification signs for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Identification signs 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 12 mm (1/2 inch) high. Identification signs 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<sup>2</sup>), 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 to the COR in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all materials and equipment before delivery to the job site. Delivery, storage or installation of materials and equipment which has not had prior approval will not be permitted.
- C. All submittals shall include six copies of adequate descriptive literature, catalog cuts, shop drawings, test reports, certifications, samples, and other data necessary for the Government to ascertain that the proposed materials and equipment comply with drawing and specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify specific materials and 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, manuals, pictures, nameplate data, and test reports as required.
  - 2. 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.
  - 3. Parts list which shall include information for replacement parts and ordering instructions, as recommended by the equipment manufacturer.
- F. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.

### **1.13 SINGULAR NUMBER**

- A. 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 ACCEPTANCE CHECKS AND TESTS**

- A. The Contractor shall furnish the instruments, materials, and labor for tests.
- B. Where systems are comprised of components specified in more than one section of Division 26, the Contractor shall coordinate the installation, testing, and adjustment of all components

between various manufacturer's representatives and technicians so that a complete, functional, and operational system is delivered to the Government.

- C. When test results indicate any defects, the Contractor shall repair or replace the defective materials or equipment, and repeat the tests. Repair, replacement, and retesting shall be accomplished at no additional cost to the Government.

#### **1.15 WARRANTY**

- A. All work performed and all equipment and material furnished under this Division shall be free from defects and shall remain so for a period of one year from the date of acceptance of the entire installation by the Contracting Officer for the Government.

#### **1.16 INSTRUCTION**

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.

#### **1.17 DRAWINGS AND SPECIFICATIONS**

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the COR for approval before proceeding with the work.
- B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the COR for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having bus duct, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install bus duct, wireways, fittings and equipment.
- D. The COR shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.
- E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33

Entrance and Access to Work Space – 110.34 Work Space and Guarding. The Electrical Contractor shall caution other trades to comply with this stipulation.

- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The COR's decision shall be final in regard to the arrangement of bus duct, conduit, etc., where conflict arises.
- G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the COR. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the COR.

#### **1.18 RECORD DRAWINGS**

- A. The Electrical Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

#### **1.19 FINAL INSPECTION AND PUNCH LIST**

- A. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the COR and request that a final inspection be made. It shall not be considered the COR's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- B. Requests to the COR for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.
- C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

#### **1.20 REMOVALS**

- A. Remove ALL existing work which will be superfluous when the new system is installed and made operational. Not all items that need to be removed are necessarily shown on the drawings. Void unused conduit behind walls or below floors as necessary or as directed. No wire or conduit shall be removed which will impair the functioning of the remaining work unless first replaced with a

rerouted section of wire or conduit to ensure continuity. Remove inactive wiring back to the last active junction box, panelboard or piece of equipment.

- B. Upon completion, no unused conduit or stub shall extend thru floors, walls or ceilings in finished areas. Abandoned conduit where remaining in place shall have any unused wiring removed. All accessible unused conduit shall be removed.
- C. When it is necessary to reroute a section of an active circuit, the rerouted section shall be installed before removing the existing in order to minimize system down time. Rerouted sections shall be installed as required for new work.

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

**PART 3 - EXECUTION (NOT USED)**

---END---

**SECTION 26 05 19**  
**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of the electrical conductors and cables for use in electrical systems rated 600 V and below, indicated as cable(s), conductor(s), wire, or wiring in this section.

**1.2 RELATED WORK**

- A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-resistant rated construction.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- 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 fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for conductors and cables.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 FACTORY TESTS**

- A. Conductors and cables shall be thoroughly tested at the factory per NEMA to ensure that there are no electrical defects. Factory tests shall be certified.

**1.5 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit the following data for approval:
      - 1) Electrical ratings and insulation type for each conductor and cable.
      - 2) Splicing materials and pulling lubricant.
  - 2. Certifications: Two weeks prior to final inspection, submit the following.
    - a. Certification by the manufacturer that the conductors and cables conform to the requirements of the drawings and specifications.
    - b. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, 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):
  - D2301-10..... Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
  - D2304-10..... Test Method for Thermal Endurance of Rigid Electrical Insulating Materials
  - D3005-10..... Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- C. National Electrical Manufacturers Association (NEMA):
  - WC 70-09 ..... Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- D. National Fire Protection Association (NFPA):
  - 70-11 ..... National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 44-10 ..... Thermoset-Insulated Wires and Cables
  - 83-08 ..... Thermoplastic-Insulated Wires and Cables
  - 467-07 ..... Grounding and Bonding Equipment
  - 486A-486B-03..... Wire Connectors
  - 486C-04..... Splicing Wire Connectors
  - 486D-05..... Sealed Wire Connector Systems
  - 486E-09..... Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  - 493-07 ..... Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
  - 514B-04..... Conduit, Tubing, and Cable Fittings

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA, UL, as specified herein, and as shown on the drawings.
- B. All conductors shall be copper.
- C. Single Conductor and Cable:
  - 1. No. 12 AWG: Minimum size, except where smaller sizes are specified herein or shown on the drawings.
  - 2. No. 8 AWG and larger: Stranded.

3. No. 10 AWG and smaller: Solid; except shall be stranded for final connection to motors, transformers, and vibrating equipment.

D. Color Code:

1. No. 10 AWG and smaller: Solid color insulation or solid color coating.
2. No. 8 AWG and larger: 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.
  - c. Color using 19 mm (0.75 inches) wide tape.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
5. Conductors shall be color-coded as follows:

208/120 V	Phase	480/277 V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray *
* or white with colored (other than green) tracer.		

6. Lighting circuit "switch legs", and 3-way and 4-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 COR.
7. Color code for isolated power system wiring shall be in accordance with the NEC.

## 2.2 SPLICES

- A. Splices shall be in accordance with NEC and UL.
- B. Above Ground Splices for No. 10 AWG and Smaller:
  1. Solderless, screw-on, reusable pressure cable type, with integral insulation, approved for copper and aluminum conductors.
  2. The integral insulator shall have a skirt to completely cover the stripped conductors.
  3. The number, size, and combination of conductors used with the connector, as listed on the manufacturer's packaging, shall be strictly followed.
- C. Above Ground Splices for 8 AWG and Larger:
  1. Long barrel "butt-splice" or "sleeve" type compression connectors, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
  2. Insulate with materials approved for the particular use, location, voltage, and temperature. Insulation level shall be not less than the insulation level of the conductors being joined.
  3. Splice and insulation shall be product of the same manufacturer.

- D. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.

## **2.3 CONNECTORS AND TERMINATIONS**

- A. Mechanical type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
- B. Long barrel compression type of high conductivity and corrosion-resistant material, with minimum of two compression indents per wire, listed for use with copper and aluminum conductors.
- C. All bolts, nuts, and washers used to connect connections and terminations to bus bars or other termination points shall be cadmium-plated steel.

## **2.4 CONTROL WIRING**

- A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified herein, except that the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be sized such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

## **2.5 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 conductors in accordance with the NEC, as specified, and as shown on the drawings.
- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pullboxes, manholes, or handholes.
- D. Conductors of different systems (e.g., 120 V and 277 V) shall not be installed in the same raceway.
- 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. In panelboards, cabinets, wireways, switches, enclosures, and equipment assemblies, neatly form, train, and tie the conductors with non-metallic ties.
- G. For connections to motors, transformers, and vibrating equipment, stranded conductors shall be used only from the last fixed point of connection to the motors, transformers, or vibrating equipment.
- H. Use expanding foam or non-hardening duct-seal to seal conduits entering a building, after installation of conductors.
- I. Conductor and Cable Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling. Use lubricants approved for the cable.
  - 2. Use nonmetallic pull ropes.

3. Attach pull ropes by means of either woven basket grips or pulling eyes attached directly to the conductors.
  4. All conductors in a single conduit shall be pulled simultaneously.
  5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- J. No more than three branch circuits shall be installed in any one conduit.
- K. When stripping stranded conductors, use a tool that does not damage the conductor or remove conductor strands.

### **3.2 SPLICE AND TERMINATION INSTALLATION**

- A. Splices and terminations shall be mechanically and electrically secure, and tightened to manufacturer's published torque values using a torque screwdriver or wrench.
- B. Where the Government determines that unsatisfactory splices or terminations have been installed, replace the splices or terminations at no additional cost to the Government.

### **3.3 CONDUCTOR IDENTIFICATION**

- A. When using colored tape to identify phase, neutral, and ground conductors larger than No. 8 AWG, apply tape in half-overlapping turns for a minimum of 75 mm (3 inches) from terminal points, and in junction boxes, pullboxes, 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.

### **3.4 FEEDER CONDUCTOR IDENTIFICATION**

- A. In each interior pullbox, install brass tags on all feeder conductors to clearly designate their circuit identification and voltage. The tags shall be the embossed type, 40 mm (1-1/2 inches) in diameter and 40 mils thick. Attach tags with plastic ties.

### **3.5 EXISTING CONDUCTORS**

- A. Unless specifically indicated on the plans, existing conductors shall not be reused.

### **3.6 CONTROL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections, install control wiring and connect to equipment to perform the required functions as specified or as shown on the drawings.
- B. Install a separate power supply circuit for each system, except where otherwise shown on the drawings.

### **3.7 CONTROL 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.

### **3.8 ACCEPTANCE CHECKS AND TESTS**

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
1. Visual Inspection and Tests: Inspect physical condition.
  2. Electrical tests:
    - a. After installation but before connection to utilization devices, such as fixtures, motors, or appliances, test conductors phase-to-phase and phase-to-ground resistance with an insulation resistance tester. Existing conductors to be reused shall also be tested.
    - b. Applied voltage shall be 500 V DC for 300 V rated cable, and 1000 V DC for 600 V 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 V rated cable and 100 megohms for 600 V rated cable.
    - c. Perform phase rotation test on all three-phase circuits.

---END---

**SECTION 26 05 26**  
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing of grounding and bonding equipment, indicated as grounding equipment in this section.
- B. "Grounding electrode system" refers to grounding electrode conductors and all electrodes required or allowed by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.
- C. The terms "connect" and "bond" are used interchangeably in this section and have the same meaning.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES), in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

**1.4 SUBMITTALS**

- A. Submit six copies of the following in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
  - 1. Shop Drawings:
    - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
    - b. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.
  - 2. Test Reports:
    - a. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.
  - 3. Certifications:
    - a. Certification by the Contractor that the grounding equipment has been properly installed 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. 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
  - B8-11..... Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
  - 81-83 ..... IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
- D. National Fire Protection Association (NFPA):
  - 70-11 ..... National Electrical Code (NEC)
  - 70E-12..... National Electrical Safety Code
  - 99-12 ..... Health Care Facilities
- E. Underwriters Laboratories, Inc. (UL):
  - 44-10 ..... Thermoset-Insulated Wires and Cables
  - 83-08 ..... Thermoplastic-Insulated Wires and Cables
  - 467-07 ..... Grounding and Bonding Equipment

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment grounding conductors shall be insulated stranded copper, except that sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified per NEC.
- B. Bonding conductors shall be bare stranded copper, except that sizes No. 10 AWG and smaller shall be bare solid copper. Bonding conductors shall be stranded for final connection to motors, transformers, and vibrating equipment.
- 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 CONNECTIONS

- A. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.
- B. Above Grade:
  - 1. Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG,

- use mechanical type lugs. Connectors or lugs shall use cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
2. Connection to Building Steel: Exothermic-welded type connectors.
  3. Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

## **2.3 GROUND TERMINAL BLOCKS**

- A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide mechanical type lugs, with cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

## **2.4 GROUNDING BUS BAR**

- A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 6.3 mm (0.25 inch) thick x 100 mm (4 inches) high in cross-section, length as shown on the drawings, with hole size, quantity, and spacing per detail shown on the drawings. Provide insulators and mounting brackets.

# **PART 3 - EXECUTION**

## **3.1 GENERAL**

- A. Install grounding equipment in accordance with the NEC, as shown on the drawings, and as specified herein.
- B. Equipment Grounding: Metallic piping, building structural steel, electrical 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**

- A. Make grounding connections, which are normally buried or otherwise inaccessible, 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 Structural 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 structural steel, and supplemental or made electrodes. Provide jumpers across insulating joints in the metallic piping.
  2. Provide a supplemental ground electrode as shown on the drawings and bond to the grounding electrode system.
- C. Panelboards, and other electrical equipment:
  1. Connect the equipment grounding conductors to the ground bus.



2. Connect metallic conduits by grounding bushings and equipment grounding conductor to the equipment ground bus.

### **3.4 RACEWAY**

#### **A. Conduit Systems:**

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Metallic 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.
4. 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 equipment 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 (except for special grounding systems for intensive care units and other critical units shown).
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 electrical continuity throughout the wireway system, by connecting a No. 6 AWG bonding jumper at all intermediate metallic enclosures and across all section junctions.
2. Install insulated No. 6 AWG bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 16 M (50 feet).
3. Use insulated No. 6 AWG 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 bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 M (49 feet).

#### **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. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- G. Panelboard Bonding in Patient Care Areas: The equipment grounding terminal buses of the normal and essential branch circuit panel boards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 10 AWG, installed in rigid metal conduit.

### **3.5 CORROSION INHIBITORS**

- A. When making grounding and 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 ACCEPTANCE CHECKS AND TESTS**

- A. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized or connected to the electric utility company ground system, and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall.
- B. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- C. Below-grade connections shall be visually inspected by the COR prior to backfilling. The Contractor shall notify the COR 24 hours before the connections are ready for inspection.

---END---

**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 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- B. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- 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**

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.
  - 3. Layout of required conduit penetrations through structural elements.
- C. Certifications:
  - 1. Two weeks prior to the final inspection, submit four copies of the following certifications to the COR:
    - 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 0.75 in unless otherwise shown.
- 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, for conduit under 2".
    - d. Setscrew couplings and connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding, for conduit 2" and larger.
    - e. Indent-type connectors or couplings are prohibited.
    - f. 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.
- 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. Cutting or Holes:
  - 1. Cut holes in advance where they should be placed in the structural elements, such as ribs or beams. Obtain the approval of the COR prior to drilling through structural elements.
  - 2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the COR as required by limited working space.
- B. Firestop: Where conduits, wireways, and other electrical raceways 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.
- C. Waterproofing: At floor and exterior wall 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. 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 COR.

### **3.3 CONCEALED WORK INSTALLATION**

- A. In Concrete:
1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
  2. Align and run conduit in direct lines.
  3. Install conduit through concrete beams only:
    - a. Where shown on the structural drawings.
    - b. As approved by the COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.

4. Installation of conduit in concrete that is less than 3 in [75 mm] thick is prohibited.
    - a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
    - b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
    - c. Install conduits approximately in the center of the slab so that there will be a minimum of 0.75 in [19 mm] of concrete around the conduits.
  5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.
- B. Above Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors 600 V and below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
  2. Align and run conduit parallel or perpendicular to the building lines.
  3. 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 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.
- C. Align and run conduit parallel or perpendicular to the building lines.
- D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.
- E. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
- F. Surface metal raceways: Use only where shown.

### **3.5 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.

### **3.6 EXPANSION JOINTS**

- A. Conduits 3 in [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 in [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.

### **3.7 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. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
  - 2. 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. Hollow Masonry: Toggle bolts.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.
- K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.
- L. 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.

### **3.8 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. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.
- E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] deep, with device covers for the wall material and thickness involved.
- F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."
- G. On all branch circuit junction box covers, identify the circuits with black marker.

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**SECTION 27 05 11**  
**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.
- B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

**1.2 MINIMUM REQUIREMENTS**

- A. References to industry and trade association standards and codes 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 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.

**1.4 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 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.

### **1.5 EQUIPMENT REQUIREMENTS**

Where variations from the contract requirements are requested in accordance with the 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.

### **1.6 EQUIPMENT PROTECTION**

- A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
  1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Damaged equipment shall be, as determined by the Contracting Officer's Representative, placed in first class operating condition or be returned to the source of supply for repair or replacement.
  3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
  4. 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.

### **1.7 WORK PERFORMANCE**

- A. Job site safety and worker safety is the responsibility of the contractor.
- B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.
- C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.
- D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

### **1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS**

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. 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 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.

### **1.9 EQUIPMENT IDENTIFICATION**

- A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

### **1.10 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. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
  3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

#### **1.11 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.

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**SECTION 27 10 00  
STRUCTURED CABLING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of the structured cabling system to provide a comprehensive telecommunications infrastructure.

**1.2 RELATED WORK**

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

**1.3 SUBMITTALS**

- A. In accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
  - 1. Manufacturer's Literature and Data: Showing each cable type and rating.
  - 2. Certificates: Two weeks prior to final inspection, deliver to the COR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

**1.4 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 the basic designation only.
- B. American Society of Testing Material (ASTM):
  - D2301-04.....Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
- C. Federal Specifications (Fed. Spec.):
  - A-A-59544-00.....Cable and Wire, Electrical (Power, Fixed Installation)
- D. National Fire Protection Association (NFPA):
  - 70-05 .....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
  - 44-02 .....Thermoset-Insulated Wires and Cables
  - 83-03 .....Thermoplastic-Insulated Wires and Cables
  - 467-01 .....Electrical Grounding and Bonding Equipment
  - 486A-01 .....Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - 486C-02.....Splicing Wire Connectors

486D-02.....	Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
486E-00.....	Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
493-01 .....	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
514B-02.....	Fittings for Cable and Conduit
1479-03 .....	Fire Tests of Through-Penetration Fire Stops

## **PART 2 - PRODUCTS**

### **2.1 CONTROL WIRING**

- A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.
- B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

### **2.2 COMMUNICATION AND SIGNAL WIRING**

- A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.
- B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.
- C. Multi-conductor cables shall have the conductors color coded.

### **2.3 WIRE LUBRICATING COMPOUND**

- A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.
- B. Shall not be used on wire for isolated type electrical power systems.

### **2.4 FIREPROOFING TAPE**

- A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame-retardant elastomer.
- B. The tape shall be self-extinguishing and shall not support combustion. It shall be arc-proof and fireproof.
- C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.
- D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.
- E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. All wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit.
- B. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.
- C. Wire Pulling:
  - 1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
  - 2. Use ropes made of nonmetallic material 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 Contracting Officer's Representative.
  - 4. Pull in multiple cables together in a single conduit.

### **3.2 CONTROL, COMMUNICATION 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. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de-energizing of the systems.
- D. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

### **3.3 CONTROL, COMMUNICATION AND SIGNAL SYSTEM 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.

### **3.4 EXISTING WIRING**

Unless specifically indicated on the plans, existing wiring shall not be reused for the new installation. Only wiring that conforms to the specifications and applicable codes may be reused. If existing wiring does not meet these requirements, existing wiring may not be reused and new wires shall be installed.

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**SECTION 27 11 00**  
**COMMUNICATIONS EQUIPMENT ROOM FITTINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Digital Cable Distribution System (here-in-after referred to as "*the System*"), and associated equipment and hardware to be installed in the VA Medical Center here-in-after referred to as "the Facility". The System shall include, but not be limited to: cable "patch", "punch down", . The System shall additionally include, but not be limited to: telecommunications outlets (TCO); copper distribution cables, connectors, "patch" cables.
- B. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.
- C. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, and tested, by the Contractor.
- D. The Digital Telecommunication Distribution Cable Equipment and System provides the media which data information travels over.
- E. The VA Project Manager (PM) and/or if delegated, COR are the approving authorities for all contractual and mechanical changes to the System. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the COR before proceeding with the change.
- F. System Performance:
  - 1. At a minimum, the System shall be able to support the following data operations for Category 5e Certified Telecommunication Service:
    - a. Provide the following interchange (or interface) capabilities:
      - 1) Basic Rate (BRI).
      - 2) Primary Rate (PRI).
    - b. ISDN
      - 1) Narrow Band BRI:
        - a) B Channel: 64 kilo-Bits per second (kBps), minimum.
        - b) D Channel: 16 kBps, minimum.
        - c) H Channel: 384 kBps, minimum.
      - 2) Narrow Band PRI:
        - a) B Channel: 64 kBps, minimum.
        - b) D Channel: 64 kBps, minimum.
        - c) H Channel: 1,920 kBps, minimum.

- 3) Wide (or Broad) Band: All channels: 140 mega(m)-Bps, minimum, capable to 565 mBps at "T" reference.
2. At a minimum the System shall support the following operating parameters:
  - a. EPBX connection:
    - 1) System speed: 1.0 gBps per second, minimum.
    - 2) Impedance: 600 Ohms.
    - 3) Cross Modulation: -60 deci-Bel (dB).
    - 4) Hum Modulation: -55 dB.
    - 5) System data error: 10 to the -10 Bps, minimum.
    - 6) Loss: Measured at the frame output with reference Zero (0) deciBel measured (dBm) at 1,000 Hertz (Hz) applied to the frame input.
      - a) Trunk to station: 1.5 dB, maximum.
      - b) Station to station: 3.0 dB, maximum.
      - c) Internal switch crosstalk: -60 dB when a signal of  $\pm 10$  deciBel measured (dBm), 500-2,500 Hz range is applied to the primary path.
      - d) Idle channel noise: 25 dBm "C" or 3.0 dBm "O" above reference (terminated) ground noise, whichever is greater.
      - e) Traffic Grade of Service for Voice and Data:
        - (1) A minimum grade of service of P-01 with an average traffic load of 7.0 CCS per station per hour and a traffic overload in the data circuits will not interfere with, or degrade, the voice service.
        - (2) Average CCS per voice station: The average CCS capacity per voice station shall be maintained at 7.0 CCS when the EPBX is expanded up to the projected maximum growth as stated herein.
  - b. Telecommunications Outlet (TCO):
    - 1) Data:
      - a) Isolation (outlet-outlet): 24 dB.
      - b) Impedance: 600 Ohms, BAL.
      - c) Signal Level: 0 dBmV  $\pm$  0.1 dBmV.
      - d) System speed: 120 mBps, minimum.
      - e) System data error: 10 to the -8 Bps, minimum.

## 1.2 RELATED WORK

- A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Specification Section 27 10 00, STRUCTURED CABLING.

### 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.
- B. National Fire Protection Association (NFPA):

70	NATIONAL ELECTRICAL CODE (NEC)
75	Protection of Electronic Computer/Data Processing Equipment
77	Recommended Practice on Static Electricity
	Standard for Health Care Facilities
101	Life Safety Code
1221	Emergency Services Communication Systems

- C. Underwriters Laboratories, Inc. (UL):

65	Wired Cabinets
96	Lightning Protection Components
96A	INSTALLATION REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEMS
467	Grounding and Bonding Equipment
497/497A/497B	PROTECTORS FOR PAIRED CONDUCTORS/ COMMUNICATIONS CIRCUITS/DATA COMMUNICATIONS AND FIRE ALARM CIRCUITS
884	Underfloor Raceways and Fittings

- D. ANSI/EIA/TIA Publications:

568B	Commercial Building Telecommunications Wiring Standard
569B	Commercial Building Standard for Telecommunications Pathways and Spaces
606A	ADMINISTRATION STANDARD FOR THE TELECOMMUNICATIONS INFRASTRUCTURE OF COMMERCIAL BUILDINGS
607A	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings
758	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings

- E. Lucent Technologies: Document 900-200-318 "Outside Plant Engineering Handbook".
- F. International Telecommunication Union – Telecommunication Standardization Sector (ITU-T).

- G. Federal Information Processing Standards (FIPS) Publications.
- H. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.
- I. United States Air Force: Technical Order 33K-I-IOO Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.
- J. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.
- K. National and/or Government Life Safety Code(s): The more stringent of each listed code.

#### **1.4 QUALITY ASSURANCE**

- A. The authorized representative of the OEM, shall be responsible for the design, satisfactory total operation of the System, and its certification.
- B. The OEM shall meet the minimum requirements identified in Paragraph 2.1.A. Additionally, the Contractor shall have had experience with three or more installations of systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identification of these installations shall be provided as a part of the submittal as identified in Paragraph 1.5.
- C. The System Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The System Contractor shall be authorized by the OEM to certify and warranty the installed equipment. In addition, the OEM and System Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certification must be provided in writing as part of the Contractor's Technical Submittal.
- D. All equipment, cabling, terminating hardware, TCOs, and patch cords shall be sourced from the certifying OEM or at the OEM's direction, and support the System design, the OEM's quality control and validity of the OEM's warranty.
- E. The Contractor's Telecommunications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the COR before being allowed to commence work on the System.

#### **1.5 SUBMITTALS**

- A. Provide submittals in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. The COR shall retain one copy for review and approval.
  - 1. If the submittal is approved the COR shall retain one copy for Official Records and return three (3) copies to the Contractor.

2. If the submittal is disapproved, three (3) copies will be returned to the Contractor with a written explanation attached that indicates the areas the submittal deviated from the System specifications. The COR shall retain one copy for Official Records.
- B. Documents: The submittal shall be separated into sections for each subsystem and shall contain the following:
  1. Title page to include:
    - a. VA Medical Center.
    - b. Contractor's name, address, and telephone (including FAX) numbers.
    - c. Date of Submittal.
    - d. VA Project No.
  2. A List of the equipment to be furnished. The quantity, make, and model number of each item is required.
  3. Equipment technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
  4. List of test equipment as per paragraph 1.5.D. below.
- C. Test Equipment List:
  1. The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested.
  2. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
    - a. TIA Category 5e cable tester
- D. Certifications:
  1. Submit written certification from the OEM indicating that the proposed supervisor of the installation and the proposed provider of the contract maintenance are authorized representatives of the OEM. Include the individual's exact name and address and OEM credentials in the certification.
- E. Record Wiring Diagrams:
  1. Fifteen (15) working days prior to the acceptance test, the Contractor shall deliver four complete sets of the Record Wiring Diagrams of the System to the COR. The diagrams shall show all inputs and outputs of electronic and passive equipment correctly identified according to the markers installed on the interconnecting cables, Equipment and room/area locations.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS**

#### **A. System Requirements:**

1. The System shall provide the following minimum services that are designed in accordance with and supported by an Original Equipment Manufacturer (OEM), and as specified herein. The System shall provide continuous inter and/or intra-Facility data, service. The System shall be capacity sized so that loss of connectivity to external telephone systems shall not affect the Facilities operation in specific designated locations. The System shall:
  - a. Be capable of inter-connecting and functioning fully with the existing local area networks (LAN), at a minimum.
  - b. Be a data cable distribution system that is based on a physical "Star" Topology.
2. Specific Subsystem Requirements: The System shall consist, as a minimum, of the following independent sub-systems to comprise a complete and functional digital telecommunications cabling system: TCO's with RJ-45 jacks for the appropriate Data connections and patch cords.

#### **B. System Performance:**

1. At a minimum, the System shall be able to support the following data operations for Category 5e Certified Telecommunication Service:
  - a. Provide the following interchange (or interface) capabilities:
    - 1) Basic Rate (BRI).
    - 2) Primary Rate (PRI).
  - b. ISDN
    - 1) Narrow Band BRI.
      - a) B Channel: 64 kilo-Bits per second (kBps), minimum.
      - b) D Channel: 16 kBps, minimum.
      - c) H Channel: 384 kBps, minimum.
    - 2) Narrow Band PRI:
      - a) B Channel: 64 kBps, minimum.
      - b) D Channel: 64 kBps, minimum.
      - c) H Channel: 1,920 kBps, minimum.
    - 3) Wide (or Broad) Band:
      - a) All channels: 140 mega (m)-Bps, minimum, capable to 565 mBps at "T" reference.
2. At a minimum the System shall support the following operating parameters:
  - a. Telecommunications Outlet (TCO):
    - 2) Data:
      - a) Isolation (outlet-outlet): 24 dB.
      - b) Impedance: 600 Ohms, BAL.

- c) Signal Level: 0 dBmV  $\pm$  0.1 dBmV.
- d) System speed: 120 mBps, minimum.
- e) System data error: 10 to the -8 Bps, minimum.

C. General:

1. All equipment to be supplied under this specification shall be new and the current model of a standard product of an OEM or record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
  - a. Maintains a stock of replacement parts for the item submitted.
  - b. Maintains engineering drawings, specifications, and operating manuals for the items submitted.
  - c. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
2. Specifications of equipment as set forth in this document are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity, or performance characteristics of items furnished in the System. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.
3. The Contractor shall provide written verification, in writing to the COR at time of installation, that the type of wire/cable being provided is recommended and approved by the OEM. The Contractor is responsible for providing the proper size and type of cable duct and/or conduit and wiring even though the actual installation may be by another subcontractor.
4. All interconnecting twisted pair cables shall be terminated on equipment terminal boards. The Contractor shall not leave unused or spare twisted pair wire cable unterminated, unconnected, loose or unsecured.
5. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING.
6. All equipment faceplates utilized in the System shall be stainless steel, anodized aluminum, or UL approved cyclac plastic for the areas where provided.

D. Equipment Functional Characteristics:

<b>FUNCTIONS</b>	<b>CHARACTERISTICS</b>
Input Voltage	105 to 130 VAC
POWER LINE FREQUENCY	60 HZ $\pm$ 2.0 HZ



Operating Temperature	0 to 50 degrees (°) Centigrade (C)
Humidity	80 percent (%) minimum rating

E. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Care performing Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials or equipment. See paragraph minimum requirements Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, and the guidelines listed in paragraph 2.J.2.
3. The provided active and passive equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the COR approved system equipment necessary to be replaced) was technically reviewed and approved by VA. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. Product Delivery, Storage and Handling:

1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The COR may inventory the cable, patch panels, and related equipment.
2. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the COR.

B. System Installation:

1. After the contract's been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the COR and PM.
2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this

specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.

3. The Contractor shall install suitable filters, traps, directional couplers, splitters, TC's, and pads for minimizing interference and for balancing the System. Items used for balancing and minimizing interference shall be able to pass data signals in the frequency bands selected, in the direction specified, with low loss, and high isolation, and with minimal delay of specified frequencies and signals. The Contractor shall provide all equipment necessary to meet the requirements of the System performance standards.
4. All passive equipment shall be connected according to the OEM's specifications to insure future correct termination, isolation, impedance match, and signal level balance at each telephone/data outlet.
5. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
6. All lines shall be terminated in a suitable manner to facilitate future expansion of the System. There shall be a minimum of one spare 25 pair cable at each distribution point on each floor.

C. Conduit and Signal Ducts:

1. Conduit:
  - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 19 mm (3/4 in.).
  - b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the COR if requested.) Conduits shall be provided in accordance with NEC Article 800 for Communications systems, at a minimum.
  - c. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
2. Signal Duct, Cable Duct, or Cable Tray:
  - a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the COR.
  - b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves,

guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.

- c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The COR shall approve width and height dimensions.
- D. Connectors: Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system.
  1. Wires:
    - a. Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire. Tape of any type is not acceptable.
    - b. Audio spade lugs shall be installed on each wire (including spare or unused) end and connect to screw terminals of appropriate size barrier strips. AC barrier strips shall be provided with a protective cover to prevent accidental contact with wires carrying live AC current. Punch blocks are approved for signal, not AC wires. Wire Nut or "Scotch Lock" connectors are not acceptable for signal wire installation.
  2. Cables: Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, wirewrap, etc.
- E. AC Power: AC power wiring shall be run separately from signal cable.
- F. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for data circuits shall be stenciled using thermal ink transfer process Handwritten labels are not acceptable.
  1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
  2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
  3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
  4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams".

### 3.2 TESTS

- A. Verification Tests:
  - 1. Test the UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test the operation of shorting bars in connection blocks. Test cables after termination and prior to cross-connection.
- B. Performance Testing:
  - 1. Perform Category 5e tests in accordance with ANSI/EIA/TIA-568-B.1 and ANSI/EIA/TIA-568-B.2. Test shall include the following: wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
- C. Total System Acceptance Test: The Contractor shall perform verification tests for UTP copper cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.
  - 1. Data Testing: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network is achieved.

### 3.3 WARRANTY

- A. Comply with FAR clause 52.246-21, except that warranty shall be as follows:
  - 1. The Contractor shall warranty that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the COR (or Facility Contracting Officer if the Facility has taken possession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
  - 2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.
  - 3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
- B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use, accidents, other vendor, contractor, owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the COR or Facility Contracting Officer in writing upon the discovery of these incidents. The COR or Facility Contracting Officer will investigate all reported incidents and render findings concerning any Contractor's responsibility.

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**SECTION 27 15 00**  
**COMMUNICATIONS HORIZONTAL CABLING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "*the System*"), and associated equipment and hardware to be installed in the VA Medical Center here-in-after referred to as "the Facility". The System shall include, but not be limited to: telecommunications outlets (TCO); copper distribution cables, connectors, "patch" cables, and/or "break out" devices.
- B. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.
- C. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, and tested, by the Contractor.
- D. The VA Project Manager (PM) and/or if delegated, Contracting Officer's Representative (COR) are the approving authorities for all contractual and mechanical changes to the System. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the COR before proceeding with the change.
- E. System Performance:
  - 1. At a minimum, the System shall be able to support the following data operations for Category 5eCertified Telecommunication Service:
    - a. Provide the following interchange (or interface) capabilities:
      - 1) Basic Rate (BRI).
      - 2) Primary Rate (PRI).
    - b. ISDN
      - 1) Narrow Band BRI:
        - a) B Channel: 64 kilo-Bits per second (kBps), minimum.
        - b) D Channel: 16 kBps, minimum.
        - c) H Channel: 384 kBps, minimum.
      - 2) Narrow Band PRI:
        - a) B Channel: 64 kBps, minimum.
        - b) D Channel: 64 kBps, minimum.
        - c) H Channel: 1,920 kBps, minimum.
    - 3) Wide (or Broad) Band: All channels: 140 mega(m)-Bps, minimum, capable to 565 mBps at "T" reference.

2. At a minimum the System shall support the following operating parameters:

a. Telecommunications Outlet (TCO):

1) Voice:

- a) Isolation (outlet-outlet): 24 dB.
- b) Impedance: 600 Ohms, balanced (BAL).
- c) Signal Level: 0 deciBel per mili-Volt (dBmV)  $\pm$  0.1 dBmV.
- d) System speed: 100 mBps, minimum.
- e) System data error: 10 to the -6 Bps, minimum.

2) Data:

- a) Isolation (outlet-outlet): 24 dB.
- b) Impedance: 600 Ohms, BAL.
- c) Signal Level: 0 dBmV  $\pm$  0.1 dBmV.
- d) System speed: 120 mBps, minimum.
- e) System data error: 10 to the -8 Bps, minimum.

## 1.2 RELATED WORK

- A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Specification Section 27 10 00, STRUCTURED CABLING.

## 1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.
- B. National Fire Protection Association (NFPA):

70	NATIONAL ELECTRICAL CODE (NEC)
75	Protection of Electronic Computer/Data Processing Equipment
77	Recommended Practice on Static Electricity
	Standard for Health Care Facilities
101	Life Safety Code
1221	Emergency Services Communication Systems

C. Underwriters Laboratories, Inc. (UL):

65	Wired Cabinets
96	Lightning Protection Components
96A	INSTALLATION REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEMS

467	Grounding and Bonding Equipment
497/497A/497B	PROTECTORS FOR PAIRED CONDUCTORS/ COMMUNICATIONS CIRCUITS/DATA COMMUNICATIONS AND FIRE ALARM CIRCUITS
884	Underfloor Raceways and Fittings

D. ANSI/EIA/TIA Publications:

568B	Commercial Building Telecommunications Wiring Standard
569B	Commercial Building Standard for Telecommunications Pathways and Spaces
606A	ADMINISTRATION STANDARD FOR THE TELECOMMUNICATIONS INFRASTRUCTURE OF COMMERCIAL BUILDINGS
607A	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings
758	Grounding and Bonding Requirements for Telecommunications in Commercial Buildings

- E. Lucent Technologies: Document 900-200-318 "Outside Plant Engineering Handbook".
- F. International Telecommunication Union – Telecommunication Standardization Sector (ITU-T).
- G. Federal Information Processing Standards (FIPS) Publications.
- H. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.
- I. United States Air Force: Technical Order 33K-I-IOO Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.
- J. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.
- K. National and/or Government Life Safety Code(s): The more stringent of each listed code.

#### 1.4 QUALITY ASSURANCE

- A. The authorized representative of the OEM, shall be responsible for the design, satisfactory total operation of the System, and its certification.
- B. The OEM shall meet the minimum requirements identified in Paragraph 2.1.A. Additionally, the Contractor shall have had experience with three or more installations of systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identification of these installations shall be provided as a part of the submittal as identified in Paragraph 1.5.
- C. The System Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The System Contractor shall be authorized by the OEM to certify and warranty the installed equipment. In

addition, the OEM and System Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certification must be provided in writing as part of the Contractor's Technical Submittal.

- D. All equipment, cabling, terminating hardware, TCOs, and patch cords shall be sourced from the certifying OEM or at the OEM's direction, and support the System design, the OEM's quality control and validity of the OEM's warranty.
- E. The Contractor's Telecommunications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the COR before being allowed to commence work on the System.

### **1.5 SUBMITTALS**

- A. Provide submittals in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. The COR shall retain one copy for review and approval.
  - 1. If the submittal is approved the COR shall retain one copy for Official Records and return three (3) copies to the Contractor.
  - 2. If the submittal is disapproved, three (3) copies will be returned to the Contractor with a written explanation attached that indicates the areas the submittal deviated from the System specifications. The COR shall retain one copy for Official Records.
- B. Documents: The submittal shall be separated into sections for each subsystem and shall contain the following:
  - 1. Title page to include:
    - a. VA Medical Center.
    - b. Contractor's name, address, and telephone (including FAX) numbers.
    - c. Date of Submittal.
    - d. VA Project No.
  - 2. List containing a minimum of three locations of installations of similar size and complexity as identified herein. These locations shall contain the following:
    - a. Installation Location and Name.
    - b. Owner's or User's name, address, and telephone (including FAX) numbers.
    - c. Date of Project Start and Date of Final Acceptance by Owner.
    - d. System Project Number.
    - e. Brief (three paragraphs minimum) description of each system's function, operation, and installation.
  - 3. A List of the equipment to be furnished. The quantity, make, and model number of each item is required.



C. Test Equipment List:

1. The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested.
2. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
  - a. TIA Category 5e tester

D. Equipment Manuals: Fifteen (15) working days prior to the scheduled acceptance test, the Contractor shall deliver four complete sets of commercial operation and maintenance manuals for each item of equipment furnished as part of the System to the COR. The manuals shall detail the theory of operation and shall include narrative descriptions, pictorial illustrations, block and schematic diagrams, and parts list.

E. Record Wiring Diagrams:

1. Fifteen (15) working days prior to the acceptance test, the Contractor shall deliver four complete sets of the Record Wiring Diagrams of the System to the COR. The diagrams shall show all inputs and outputs of electronic and passive equipment correctly identified according to the markers installed on the interconnecting cables, Equipment and room/area locations.
2. The Record Wiring Diagrams shall be in hard copy and two compact disk (CD) copies properly formatted to match the Facility's current operating version of Computer Aided Drafting (AutoCAD) system. The COR shall verify and inform the Contractor of the version of AutoCAD being used by the Facility.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT AND MATERIALS**

A. System Requirements:

1. The System shall provide the following minimum services that are designed in accordance with and supported by an Original Equipment Manufacturer (OEM), and as specified herein. The System shall provide continuous inter and/or intra-Facility data service. The System shall:
  - a. Be capable of inter-connecting and functioning fully with the existing local area networks (LAN), at a minimum.
  - b. Be a data cable distribution system that is based on a physical "Star" Topology.
2. Cable Systems - Twisted Pair
  - a. General:
    - 1) The Contractor shall be responsible for providing a new system conforming to current and accepted telephone and digital commercial cable distribution standards. The

distribution cable installation shall be fully coordinated with the Facility, the PM, the COR and the Contractor prior to the start of installation.

- 2) The Contractor is responsible for complete knowledge of the space and cable pathways (i.e. equipment rooms, TCs, conduits, wireways, etc.) of the Facility. The Contractor shall at a minimum design and install the System using the Pathway Design Handbook H-088C3, TIA/EIA Telecommunications Building Wiring Standards, and Facility Chief of Information Resource Management's (IRM) instructions, as approved in writing by the PM and/or COR.
- 3) The System cables shall be fully protected by cable duct, trays, wireways, conduit (rigid, thin wall, or flex), and when specifically approved, flexible innerduct. It is the responsibility of the Contractor to confirm all contract drawings and the Facility's physical layout to determine the necessary cable protective devices to be provided. If flexible innerduct is used, it shall be installed in the same manner as conduit.
- 4) Cable provided in the system (i.e. backbone, outside plant, inside plant, and station cabling) shall conform to accepted industry and OEM standards with regards to size, color code, and insulation. The pair twists of any pair shall not be exactly the same as any other pair within any unit or sub-unit of cables that are bundled in twenty-five (25) pairs or less. The absence of specifications regarding details shall imply that best general industry practices shall prevail and that first quality material and workmanship shall be provided. Certification Standards, (i.e., EIA, CCITT, FIPPS, and NFPA) shall prevail.
- 5) Some areas of this Facility may be considered "plenum". All wire and cable used in support of the installation in those areas (if any) shall be in compliance with national and local codes pertaining to plenum environments. It is the responsibility of the Contractor to review the VA's cable and wire requirements with the COR and the IRM prior to installation to confirm the type of environment present at each location.
- 6) The Contractor shall provide outside and inside plant cables that furnishes the number of cable pairs required in accordance with the System requirements described herein. The Contractor shall fully coordinate and obtain approval of the design with the OEM, COR and the IRM prior to installation.
- 7) All metallic cable sheaths, etc. shall be grounded by the Contractor (i.e.: risers, underground, station wiring, etc.) as described herein.
- 8) If temporary cable and wire pairs are used, they shall be installed so as to not present a pedestrian safety hazard and the Contractor shall be responsible for all work associated with the temporary installation and for their removal when no longer necessary. Temporary cable installations are not required to meet Industry

Standards; but, must be reviewed and approved by the COR and the IRM prior to installation.

- 9) Conductors shall be cabled to provide protection against induction in data circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
  - 10) Measures shall be employed by the Contractor to minimize the radiation of RF noise generated by the System equipment so as not to interfere with audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
  - 11) The System's cables shall be labeled on each end and been fully tested and certified in writing by the Contractor to the COR before proof of performance testing can be conducted. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges specified. The tests required for data cable must be made to guarantee the operation of this cable at not less than 10 mega (m) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of  $10^{-6}$  at the maximum rate of speed. All cable installation and test records shall be made available at acceptance testing by the COR or Contractor and thereafter maintained in the Facility's Telephone Switch Room. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
  - 12) The Contractor shall provide proper test equipment to guarantee that cable pairs meet each OEM's standard transmission requirements, and guarantee the cable will carry data transmissions at the required speeds, frequencies, and fully loaded bandwidth.
- b. Horizontal and Station Cable:
- 1) A Four (4) UTP 24 AWG station wiring cable shall be installed from the top TCO jack to the TC and shall be of a type designed to support Category 5e communications (100 mega-Hertz [mHz] or above). At the jack location, terminate all four pair on the RJ-45/11 jack. At the signal closet, all four pair shall be terminated on the modular punch down blocks dedicated to telephone applications.
- c. Telecommunication Outlets (TCO), Jacks: All TCO's shall have RJ-45 type jacks. The jacks shall be eight pin RJ-45 type unkeyed (sometimes called center keyed) jacks, labeled, and designated for data.
3. Specific Subsystem Requirements: The System shall consist, as a minimum, of the following independent sub-systems to comprise a complete and functional digital telecommunications

cabling system: horizontal cabling systems, and TCO's with RJ-45 jacks for the appropriate Data connections, and additional patch cords, terminators, and adapters provided.

- a. Horizontal (or Station) Cabling (HC): The HC distribution cabling systems connects the distribution field of the voice and data HCCS, in a "Star" Topology, to each TCO or connector and as shown on the drawings via the sub-trunk system.
  - 1) Horizontal cables shall consist of insulated, UTP or STP conductors that are rated for Category 5e telecommunications service for voice and data systems.
  - 2) The number of UTP or STP distribution pairs dedicated to each floor from the HC shall be sufficient to accommodate all the horizontal voice and data circuits served by the distribution cable to each TCO.
  - 3) The horizontal cable length to the farthest system outlet shall be limited to a maximum of 90M (or 295 ft). These maximum lengths must be derated, adjusted and reduced to include cross-connection and distribution system losses. Additional TC(s) shall be provided on large floor areas of buildings to limit the horizontal distribution to a maximum of 90M (or 295 ft).
  - 4) The splitting of pairs within a cable between different jacks shall not be permitted.
  - 5) The installation of the HC shall conform to appropriate OEM recommendations and standards outlined herein. This requirement will insure adequate protection for Electro-Magnetic Interference (EMI) sources.
  - 6) A system design where "looping" the HC distribution cables from room to room shall not be permitted.
- b. System Telecommunication Outlets (TCO): The System shall be capable of receiving the specified data signals acquired from the LEC, FTS contracted carrier and computer system and shall process and distribute them to the designated TCO's and as shown on the drawings.
  - 1) Each TCO shall consist of multipin modular RJ45 jacks, Each TCO with appropriate jacks installed shall be provided by the Contractor in each designated location and as shown on the drawings.
  - 2) The Contractor shall connect each TCO data multipin modular RJ45 jack to a separate lower row jack on the HCCS "patch panel" in each associated RTC. The Contractor is not to "cross-connect" VCCS and HCCS data distribution cables or provides active electronic data distribution equipment as a part of the System.
  - 3) A non-impact termination method, using either a stuffer cap with installation tool or full-cycle terminating tool having both tactile and audible feedback to indicate proper termination shall be used. High impact installation tools shall not be used.

- 4) Each terminated conductor end shall be properly trimmed to assure a minimum clearance of 6.35 mm (0.250 in) clearance between the conductors of adjacent modules.
- 5) The multipin RJ45 jack shall be modular in construction that will accept and operate with a modular UTP and STP RJ45 connector and its pin assignments.

B. System Performance:

1. At a minimum, the System shall be able to support the following data operations for Category 5e Certified Telecommunication Service:
  - a. Provide the following interchange (or interface) capabilities:
    - 1) Basic Rate (BRI).
    - 2) Primary Rate (PRI).
  - b. ISDN
    - 1) Narrow Band BRI.
      - a) B Channel: 64 kilo-Bits per second (kBps), minimum.
      - b) D Channel: 16 kBps, minimum.
      - c) H Channel: 384 kBps, minimum.
    - 2) Narrow Band PRI:
      - a) B Channel: 64 kBps, minimum.
      - b) D Channel: 64 kBps, minimum.
      - c) H Channel: 1,920 kBps, minimum.
    - 3) Wide (or Broad) Band:
      - a) All channels: 140 mega(m)-Bps, minimum, capable to 565 mBps at "T" reference.
2. At a minimum the System shall support the following operating parameters:
  - a. EPBX connection:
    - 1) System speed: 1.0 gBps per second, minimum.
    - 2) Impedance: 600 Ohms.
    - 3) Cross Modulation: -60 deci-Bel (dB).
    - 4) Hum Modulation: -55 Db.
    - 5) System data error: 10 to the -10 Bps, minimum loss measured at the frame output with reference Zero (0) deciBel measured (dBm) at 1,000 Hertz (Hz) applied to the frame input.
      - a) Trunk to station: 1.5 dB, maximum.
      - b) Station to station: 3.0 dB, maximum.
      - c) Internal switch crosstalk: -60 dB when a signal of  $\pm 10$  deciBel measured (dBm), 500-2,500 Hz range is applied to the primary path.
      - d) Idle channel noise: 25 dBm "C" or 3.0 dBm "O" above reference (terminated) ground noise, whichever is greater.

- e) Traffic Grade of Service for Voice and Data:
  - (1) A minimum grade of service of P-01 with an average traffic load of 7.0 CCS per station per hour and a traffic overload in the data circuits will not interfere with, or degrade, the voice service.
  - (2) Average CCS per voice station: The average CCS capacity per voice station shall be maintained at 7.0 CCS when the EPBX is expanded up to the projected maximum growth as stated herein.
- b. Telecommunications Outlet (TCO):
  - 1) Voice:
    - a) Isolation (outlet-outlet): 24 dB.
    - b) Impedance: 600 Ohms, balanced (BAL).
    - c) Signal Level: 0 deciBel per mili-Volt (dBmV)  $\pm$  0.1 dBmV.
    - d) System speed: 100 mBps, minimum.
    - e) System data error: 10 to the -6 Bps, minimum.
  - 2) Data:
    - a) Isolation (outlet-outlet): 24 dB.
    - b) Impedance: 600 Ohms, BAL.
    - c) Signal Level: 0 dBmV  $\pm$  0.1 dBmV.
    - d) System speed: 120 mBps, minimum.
    - e) System data error: 10 to the -8 Bps, minimum.
- C. General:
  - 1. All equipment to be supplied under this specification shall be new and the current model of a standard product of an OEM or record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
    - a. Maintains a stock of replacement parts for the item submitted.
    - b. Maintains engineering drawings, specifications, and operating manuals for the items submitted.
    - c. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
  - 2. Specifications of equipment as set forth in this document are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity, or performance characteristics of items furnished in the System. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.
  - 3. The Contractor shall provide written verification, in writing to the COR at time of installation, that the type of wire/cable being provided is recommended and approved by the OEM. The

Contractor is responsible for providing the proper size and type of cable duct and/or conduit and wiring even though the actual installation may be by another subcontractor.

4. All passive distribution equipment shall meet or exceed -80 dB radiation shielding specifications.
5. All interconnecting twisted pair cables shall be terminated on equipment terminal boards, punch blocks, breakout boxes, splice blocks, and unused equipment ports/taps shall be terminated according to the OEM's instructions for telephone cable systems without adapters. The Contractor shall not leave unused or spare twisted pair wire cable unterminated, unconnected, loose or unsecured.
6. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING.
7. Connect the System's primary input AC power to the Facility' Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with COR regarding a suitable circuit location prior to bidding.
8. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and interface points. Coaxial cable distribution points and RF transmission lines shall use coaxial cable connections recommended by the cable OEM and approved by the System OEM. Base- band cable systems shall utilize barrier terminal screw type connectors, at a minimum. Crimp type connectors installed with a ratchet type installation tool are and acceptable alternate as long as the cable dress, pairs, shielding, grounding, and connections and labeling are provided the same as the barrier terminal strip connectors. Tape of any type, wire nuts, or solder type connections are unacceptable and will not be approved.
9. All equipment faceplates utilized in the System shall be stainless steel, anodized aluminum, or UL approved cyclac plastic for the areas where provided.

D. Equipment Functional Characteristics:

FUNCTIONS	CHARACTERISTICS
Input Voltage	105 to 130 VAC
POWER LINE FREQUENCY	60 HZ $\pm$ 2.0 HZ
Operating Temperature	0 to 50 degrees (°) Centigrade (C)
Humidity	80 percent (%) minimum rating

E. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Care performing Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials or equipment. See paragraph minimum requirements Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
3. The provided active and passive equipment required by the System design and approved technical submittal must conform with each UL standard in effect for the equipment, as of the date of the technical submittal (or the date when the COR approved system equipment necessary to be replaced) was technically reviewed and approved by VA. Where a UL standard is in existence for equipment to be used in completion of this contract, the equipment must bear the approved UL seal.
4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards.

## **2.2 DISTRIBUTION EQUIPMENT AND SYSTEMS**

### **A. Telecommunication Outlet (TCO):**

1. The TCO shall consist of data multipin jacks mounted in a steel outlet box. A separate 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled stainless steel faceplate will be used. A second 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled faceplate shall be provided as required adjacent to the first box to ensure system connections and expandability requirements are met.
2. All data multipin connections shall be RJ-45 female types.
3. The TCO shall be fed from the appropriate CCS located in the respective RTC in a manner to provide a uniform and balanced distribution system.
4. Interface of the data multipin jacks to appropriate patch panels (or approved "punch down" blocks) in the associated RTC, is the responsibility of the Contractor. The Contractor shall not extend data cables from the RTCs to data terminal equipment or install data terminal equipment.
5. The wall outlet shall be provided with a stainless steel or approve alternate cover plate to fit the data multi- pin jacks and the outlet box provided (100mm (4in.) x 100mm (4in.) for single and 100mm (4in.) x 200mm (8in.) for dual outlet box applications). For PBPU installations, the cover plate shall be stainless steel.



- B. Distribution Cables: Each cable shall meet or exceed the following specifications for the specific type of cable. Each cable reel shall be sweep tested and certified by the OEM by tags affixed to each reel. The Contractor shall turn over all sweep tags to the COR or PM. Additionally, the Contractor shall provide a 610 mm (2 ft.) sample of each provided cable, to the COR and receive approval before installation. Cables installed in any outside location (i.e. above ground, under ground in conduit, ducts, pathways, etc.) shall be filled with a waterproofing compound between outside jacket (not immediately touching any provided armor) and inter conductors to seal punctures in the jacket and protect the conductors from moisture.

1. Data Multi-Conductor:

- a. The cable shall be multi-conductor, shielded or unshielded cable with stranded conductors. The cable shall be able to handle the power and voltage used over the distance required. It shall meet Category 5e service at a minimum.
- b. Technical Characteristics:

Wire size	22 AWG, minimum
Working shield	350 V
Bend radius	10X the cable outside diameter
Impedance	100 Ohms $\pm$ 15%, BAL
Bandwidth	100 mHz, minimum
DC RESISTANCE	10.0 Ohms/100M, maximum
Shield coverage	
Overall Outside (if OEM specified)	100%
Individual Pairs (if OEM specified)	100%
Attenuation	
Frequency in mHz	dB per 305 M (1,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

C. Outlet Connection Cables:

1. Data:

- a. The Contractor shall provide a connection cable for each TCO data jack in the system with 10% spares. The data connection cable shall connect a data instrument to the TCO data jack. The Contractor shall not provide data terminal(s)/equipment.
- b. Technical Characteristics:

Length	1.8M (6 ft.), minimum
Cable	Data grade Category 5e
Connector	RJ-45 male on each end
Color coding	Required, data industry standard
Size	24 AWG, minimum

D. System Connectors:

1. Modular (RJ-45/11 and RJ-45): The connectors shall be commercial types for voice and high speed data transmission applications. The connector shall be compatible with telephone instruments, computer terminals, and other type devices requiring linking through the modular telecommunications outlet to the System. The connector shall be compatible with UTP and STP cables.
  - a. Technical Characteristics:

Type	Number of Pins
RJ-11/45	Compatible with RJ45
RJ-45	Eight
Dielectric	Surge
Voltage	1,000V RMS, 60 Hz @ one minute, minimum
Current	2.2A RMS @ 30 Minutes or 7.0A RMS @ 5.0 seconds
Leakage	100 $\mu$ A, maximum
Connectability	
Initial contact resistance	20 mili-Ohms, maximum
Insulation displacement	10 mili-Ohms, maximum
Interface	Must interface with modular jacks from a variety of OEMs. RJ-11/45 plugs shall provide connection when used in RJ-45 jacks.
Durability	200 insertions/withdrawals, minimum

## **2.3 TELECOMMUNICATIONS CLOSET REQUIREMENTS**

Refer to VA Handbook H-088C3, Telephone System Requirements, for specific TC guidelines for size, power input, security, and backboard mounting requirements. It is the Contractors responsibility to ensure TC compliance with the System Requirements.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

#### **A. Product Delivery, Storage and Handling:**

1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name and equipment catalog numbers, model and serial identification numbers. The COR may inventory the cable, patch panels, and related equipment.
2. Storage and Handling: Store and protect equipment in a manner, which will preclude damage as directed by the COR.

#### **B. System Installation:**

1. After the contract's been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the COR and PM.
2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.
3. The Contractor shall install suitable filters, traps, directional couplers, splitters, TC's, and pads for minimizing interference and for balancing the System. Items used for balancing and minimizing interference shall be able to pass data signals in the frequency bands selected, in the direction specified, with low loss, and high isolation, and with minimal delay of specified frequencies and signals.
4. All passive equipment shall be connected according to the OEM's specifications to insure future correct termination, isolation, impedance match, and signal level balance at each telephone/data outlet.
5. Where TCOs are installed adjacent to each other, install one outlet for each instrument.

#### **C. Conduit and Signal Ducts:**

1. Conduit:
  - a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document

as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 19 mm (3/4 in.).

- b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the COR if requested.) Conduits shall be provided in accordance with NEC Article 800 for Communications systems, at a minimum.
  - c. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.
2. Signal Duct, Cable Duct, or Cable Tray:
- a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the COR.
  - b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.
  - c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The COR shall approve width and height dimensions.

D. Distribution System Signal Wires and Cables:

1. Wires and cables shall be provided in the same manner and use like construction practices as Fire Protective and other Emergency Systems that are identified and outlined in NFPA 101, Life Safety Code, Chapters 7, 12, and/or 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions. The wires and cables shall be able to withstand adverse environmental conditions in their respective location without deterioration. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
  - a. Each wire and cable shall terminate on an item of equipment by direct connection. Spare or unused wire and cable shall be provided with appropriate connectors (female types) that are installed in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.

- b. All cable junctions and taps shall be accessible. Provide an 8" X 8" X 4" (minimum) junction box attached to the cable duct or raceway for installation of distribution system passive equipment. Ensure all equipment and tap junctions are accessible.
2. Routing and Interconnection:
- a. Wires or cables between consoles, cabinets, racks and other equipment shall be in an approved conduit, signal duct, cable duct, or cable tray that is secured to building structure.
  - b. Wires and cables shall be insulated to prevent contact with signal or current carrying conductors. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are bundled and tied. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, controls, components or terminations.
  - c. Harnesses with intertwined members are not acceptable. Each wire or cable that breaks out from a harness for connection or termination shall have been tied off at that harness or bundle point, and be provided with a neatly formed service loop.
  - d. Wires and cables shall be grouped according to service (i.e.: AC, grounds, signal, DC, control, etc.). DC, control and signal cables may be included with any group. Wires and cables shall be neatly formed and shall not change position in the group throughout the conduit run. Wires and cables in approved signal duct, conduit, cable ducts, or cable trays shall be neatly formed, bundled, tied off in 600 mm to 900 mm (24 in. to 36 in.) lengths and shall not change position in the group throughout the run. Concealed splices are not allowed.
  - e. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right. This installation shall be accomplished with ties and/or fasteners that will not damage or distort the wires or cables. Limit spacing between tied off points to a maximum of 150 mm (6 inches).
  - f. Do not pull wire or cable through any box, fitting or enclosure where change of cable tray or signal or cable duct alignment or direction occurs. Ensure the proper bend radius is maintained for each wire or cable as specified by it's OEM.
  - g. Employ temporary guides, sheaves, rollers, and other necessary items to protect the wire or cable from excess tension or damage from bending during installation. Abrasion to wire or cable jackets is not acceptable and will not be allowed. Replace all cables whose jacket has been abraded. The discovery of any abraded and/or damaged cables during the proof of performance test shall be grounds for declaring the entire system

unacceptable and the termination of the proof of performance test. Completely cover edges of wire or cable passing through holes in chassis, cabinets or racks, enclosures, pull or junction boxes, conduit, etc., with plastic or nylon grommeting.

- h. Cable runs shall be splice free between conduit junction and interface boxes and equipment locations.
- i. Cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.
- j. Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment and at each junction point in the System. The lettering on the cables shall correspond with the lettering on the record diagrams.
- k. Completely test all of the cables after installation and replace any defective cables.
- l. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.
- m. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.
  - 1) Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
  - 2) Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
  - 3) Closer wire or cable fastening intervals may be required to prevent sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
  - 4) Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the COR, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.

E. Outlet Boxes, Back Boxes, and Faceplates:

1. Outlet Boxes: Signal, power, interface, connection, distribution, and junction boxes shall be provided as required by the system design, on-site inspection, and review of the contract drawings.
  2. Back Boxes: Back boxes shall be provided as directed by the OEM as required by the approved system design, on-site inspection, and review of the contract drawings.
  3. Face Plates (or Cover Plates): Faceplates shall be of a standard type, stainless steel, anodized aluminum or UL approved cycloc plastic construction and provided by the Contractor for each identified system outlet location. Connectors and jacks appearing on the faceplate shall be clearly and permanently marked.
- F. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for voice and data circuits shall be stenciled using thermal ink transfer process . Handwritten labels are not acceptable.
1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
  2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
  3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
  4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams".

### 3.2 TESTS

- A. Performance Testing:
1. Perform Category 5e tests in accordance with ANSI/EIA/TIA-568-B.1 and ANSI/EIA/TIA-568-B.2. Test shall include the following: wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
- B. Total System Acceptance Test: The Contractor shall perform verification tests for UTP copper cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.
1. Data Testing: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network is achieved.

### 3.3 WARRANTY

- A. Comply with FAR clause 52.246-21, except that warranty shall be as follows:

1. The Contractor shall warranty that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the COR (or Facility Contracting Officer if the Facility has taken possession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
  2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.
  3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
- B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use, accidents, other vendor, contractor, owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the COR or Facility Contracting Officer in writing upon the discovery of these incidents. The COR or Facility Contracting Officer will investigate all reported incidents and render findings concerning any Contractor's responsibility.

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