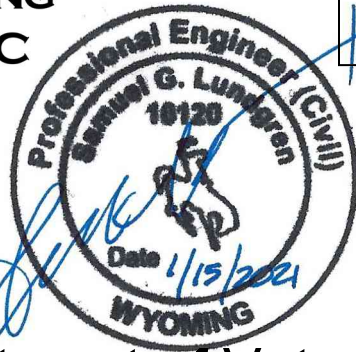




**VALHALLA
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Department of Veterans Affairs
Sheridan VAMC
Sheridan, WY

**Project Number 666-18-114
(VEG 20.07)**

**Building 90 Replace Coal Boilers
Design**

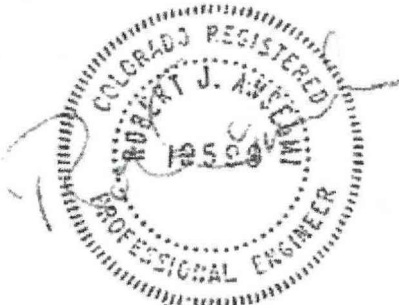


Exp 10/31/21

Technical Specifications



100% Construction Documents Submittal



1/15/2021

January 15, 2021



**DEPARTMENT OF VETERANS AFFAIRS
VHA MASTER SPECIFICATIONS**

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SECTION 00 01 15
LIST OF DRAWING SHEETS

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

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	GENERAL
GI001	Cover Sheet
	CIVIL
C-001	Civil General Notes
CD101	Civil Demolition Plan
CS101	Civil Site Plan
CS501	Civil Site Details
CG101	Civil Grading And Erosion Control Plan
CG501	Erosion And Sediment Control Details
	LANDSCAPE
LP101	Planting Plan
	STRUCTURAL
S-001	Structural General Notes
SD101	Structural Foundation Demo Plan
SD102	Structural Framing Demo Plan
S-101	Structural Foundation Plan
S-102	Structural Framing Plan
S-301	Structural Sections
S-501	Structural Foundation Details
S-502	Structural Framing Details
	MECHANICAL
M-001	Mechanical Abbreviations And General Notes
M-002	Mechanical Symbols
MD102	Pump Level Mechanical Demo Plan
MD103	Main Level Mechanical Demo Plan
MD104	Mezzanine Level Mechanical Demo Plan

MD601	Steam Flow Demo Diagram
MD602	Feedwater Flow Demo Diagram
MD603	Compressed Air Demo Diagram
MD604	Mechanical Controls Demo Diagram
MP101	Mechanical Site Plan
MP102	Pump Level Mechanical Plan
MP103	Main Level Mechanical Plan
MP104	Mezzanine Level Mechanical Plan
MP105	Roof Level Mechanical Plan
MP301	Steam Generation Section
MP501	Mechanical Details
MP502	Mechanical Details
MP503	Mechanical Details
MP602	Feedwater Flow Diagram
MP603	Steam Flow Diagram
MP604	NG And LPA Flow Diagram
MI101	Boiler Plant Controls
MI102	Boiler Controls
MI103	Plant Control Schematic
	ELECTRICAL
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E-002	Electrical Symbols
ED101	Pump Level Power Demo Plan
ED102	Main level Power Demo Plan
ED103	Mezzanine Level Power Demo Plan
ES101	Electrical Site Plan
EL101	Pump Level Lighting Plan
EL102	Main Level Lighting Plan
EL103	Lower Mezzanine Level Lighting Plan
EL104	Upper Mezzanine Level Lighting Plan
EP101	Pump Level Power Plan
EP102	Main level Power Plan
EP103	Mezzanine Level Power Plan
EJ101	Lightning Protection Plan
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E-503 Electrical Details
E-504 Electrical Details
E-601 Electrical Demo One Line Diagram
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**SECTION 01 00 00
GENERAL REQUIREMENTS**

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SECTION 01 00 00
GENERAL REQUIREMENTS

1.1 SAFETY REQUIREMENTS

Refer to section 01 35 26, SAFETY.

1.2 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 Building 90 Coal Boiler Replacement as required by drawings and specifications.
- B. Visits to the site by Bidders may be made only by appointment with the Contracting Officer's Representative (COR).
- C. Offices of Valhalla Engineering Group, 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 workdays 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.

1.3 STATEMENT OF BID ITEM(S)

- A. ITEM I, GENERAL CONSTRUCTION: Work includes general construction, patching and repair of walls, floors and roof affected by the work, alterations, roads, walks, grading, drainage, site work, necessary removal of existing structures and construction and certain other items.

ITEM II, Electrical Work: Work includes all labor, material, equipment and supervision to perform the required electrical construction work on this project including providing new power and lights for the safe operation and maintenance of the new boilers and for site improvements.

ITEM III, Mechanical Work: Work includes all labor, material, equipment and supervision to perform the required Mechanical construction work on this project including providing new boilers, piping, controls, etc as required by the contract specifications and drawings.

ITEM IV, Structural Work: Work includes all labor, material, equipment and supervision to perform the required structural construction work on this project including construction of new catwalks, modifications to existing catwalks, handrails and guard rails, catwalk access, and various structural supports for equipment and ancillary devices.

1.4 SPECIFICATIONS AND DRAWINGS FOR CONTRACTOR

- A. Drawings and contract documents may be obtained from the website where the solicitation is posted. Additional copies will be at Contractor's expense.

1.5 CONSTRUCTION SECURITY REQUIREMENTS

A. Security Plan:

1. The security plan defines both physical and administrative security procedures that will remain effective for the entire duration of the project.
2. The General Contractor is responsible for assuring that all sub-contractors working on the project and their employees also comply with these regulations.

B. Security Procedures:

1. General Contractor's employees shall not enter the project site without appropriate badge. They may also be subject to inspection of their personal effects when entering or leaving the project site.
2. Before starting work the General Contractor shall give one week's notice to the Contracting Officer so that security arrangements can be

provided for the employees. This notice is separate from any notices required for utility shutdown described later in this section.

3. No photography of VA premises is allowed without written permission of the Contracting Officer.
4. VA reserves the right to close down or shut down the project site and order General Contractor's employees off the premises in the event of a national emergency. The General Contractor may return to the site only with the written approval of the Contracting Officer.

C. Key Control:

1. The General Contractor shall provide duplicate keys and lock combinations to the Contracting Officer's Representative (COR) for the purpose of security inspections of every area of project including tool boxes and parked equipment and to take any emergency action if needed.

D. Document Control:

1. Before starting any work, the General Contractor/Sub Contractors shall submit an electronic security memorandum describing the approach to following goals and maintaining confidentiality of "sensitive information".
2. The General Contractor is responsible for safekeeping of all drawings, project manual and other project information. This information shall be shared only with those with a specific need to accomplish the project.
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 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.

E. Motor Vehicle Restrictions

1. Vehicle authorization request shall be required for any vehicle entering the site and such request shall be submitted 24 hours before the date and time of access. Access shall be restricted to picking up and dropping off materials and supplies.
2. A limited number of (2 to 5) permits shall be issued for General Contractor and its employees for parking in designated areas only.

1.6 OPERATIONS AND STORAGE AREAS

- A. The Contractor shall confine all operations (including storage of materials) on Government premises to areas authorized or approved by the Contracting Officer. The Contractor shall hold and save the Government, its officers and agents, free and harmless from liability of any nature occasioned by the Contractor's performance.
- B. Temporary buildings (e.g., storage sheds, shops, offices) and utilities may be erected by the Contractor only with the approval of the Contracting Officer and shall be built with labor and materials furnished by the Contractor without expense to the Government. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Contracting Officer, the buildings and utilities may be abandoned and need not be removed.
- C. The Contractor shall, under regulations prescribed by the Contracting Officer, use only established roadways, or use temporary roadways constructed by the Contractor when and as authorized by the Contracting Officer. When materials are transported in prosecuting the work, vehicles

shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State, or local law or regulation. When it is necessary to cross curbs or sidewalks, the Contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks, or roads.

(FAR 52.236-10)

- D. Working space and space available for storing materials shall be as determined by the COR.
- E. Workers 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 workdays. 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.
 - 4. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.
- G. Phasing:

1. The Medical Center must maintain its operation 24 hours a day 7 days a week. Therefore, any interruption in service must be scheduled and coordinated with the COR to ensure that no lapses in operation occur. It is the CONTRACTOR'S responsibility to develop a work plan and schedule detailing, at a minimum, the procedures to be employed, the equipment and materials to be used, the interim life safety measure to be used during the work, and a schedule defining the duration of the work with milestone subtasks. The work to be outlined shall include, but not be limited to:
2. To ensure 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 phasing dates to ensure accomplishment of this work in successive phases mutually agreeable to Medical Center Director, COR and Contractor, as follows:

Refer to phasing notes, M-001

- H. Building No. 90 will be occupied during performance of work.
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 through other construction areas which serve as routes of access to such affected areas and equipment. These routes whether access or egress shall be isolated from the construction area by temporary partitions and have walking surfaces, lighting etc to facilitate staff access. Coordinate alteration work in areas occupied by Department of Veterans Affairs so that Medical Center operations will continue during the construction period.
- I. When a building and/or construction site is turned over to Contractor, Contractor shall accept entire responsibility including upkeep and maintenance 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.
- J. 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 a detailed work plan, the Medical Center Director's prior knowledge and written approval. Refer to specification Sections 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, 27 05 11 REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS and 28 05 00, COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY for additional requirements.
 2. Contractor shall submit a request to interrupt any such services to COR, in writing, 7 days 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 15 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.
 6. Whenever it is required that a connection fee be paid to a public utility provider for new permanent service to the construction project, for such items as water, sewer, electricity, gas or steam, payment of such fee shall be the responsibility of the Government and not the Contractor.
- K. 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 at the main, branch or panel they originate from. 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.
- L. 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. Wherever excavation for new utility lines cross existing roads, at least one lane must be open to traffic at all times with approval.
 2. Method and scheduling of required cutting, altering and removal of existing roads, walks and entrances must be approved by the COR.
- M. 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.

1.7 ALTERATIONS

- A. Survey: Before any work is started, the Contractor shall make a thorough survey with the COR and a representative of VA Supply Service, of

buildings in which alterations occur and areas which are anticipated routes of access, and furnish a report, signed by all three, 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).
- 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 workers in executing work of this contract.
- D. Protection: Provide the following protective measures:

1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
2. Temporary protection against damage for portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.
3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.

1.8 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 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.
 4. PCB Transformers and Capacitors: The Contractor shall be responsible for disposal of the Polychlorinated Biphenyl (PCB) transformers and capacitors. The transformers and capacitors shall be taken out of

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

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

- 40 CFR 261.....Identification and Listing of Hazardous Waste
- 40 CFR 262.....Standards Applicable to Generators of Hazardous Waste
- 40 CFR 263.....Standards Applicable to Transporters of Hazardous Waste
- 40 CFR 761.....PCB Manufacturing, Processing, Distribution in Commerce, and use Prohibitions
- 49 CFR 172.....Hazardous Material tables and Hazardous Material Communications Regulations
- 49 CFR 173.....Shippers - General Requirements for Shipments and Packaging
- 49 CFR 173.....Subpart A General
- 49 CFR 173.....Subpart B Preparation of Hazardous Material for Transportation
- 49 CFR 173.....Subpart J Other Regulated Material; Definitions and Preparation
- TSCA.....Compliance Program Policy Nos. 6-PCB-6 and 6-PCB-7

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

- A. The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the work site, which are not to be removed and which do not unreasonably interfere with the work required under this contract. The Contractor shall only remove trees when specifically authorized to do so, and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workers, the Contractor shall trim those limbs or branches with a clean cut and paint the cut with a tree-pruning compound as directed by the Contracting Officer.
- B. The Contractor shall protect from damage all existing improvements and utilities at or near the work site and on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the Contracting Officer may have the necessary work performed and charge the cost to the Contractor.

(FAR 52.236-9)

- C. Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, for additional requirements on protecting vegetation, soils and the environment. Refer to Articles, "Alterations", "Restoration", and "Operations and Storage Areas" for additional instructions concerning repair of damage to structures and site improvements.
- D. Refer to FAR clause 52.236-7, "Permits and Responsibilities," which is included in General Conditions. A National Pollutant Discharge Elimination System (NPDES) permit is required for this project. The Contractor is considered an "operator" under the permit and has extensive responsibility for compliance with permit requirements. VA will make the permit application available at the (appropriate medical center) office. The apparent low bidder, contractor and affected subcontractors shall furnish all information and certifications that are required to comply with the permit process and permit requirements. Many of the permit requirements

will be satisfied by completing construction as shown and specified. Some requirements involve the Contractor's method of operations and operations planning and the Contractor is responsible for employing best management practices. The affected activities often include, but are not limited to the following:

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

1.10 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.
- C. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workers to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (including telephone) which are 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 "DIFFERING SITE CONDITIONS" (FAR 52.236-2).

1.11 PHYSICAL DATA

- A. Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

- 1. The indications of physical conditions on the drawings and in the specifications are the result of site investigations by

_____.

(FAR 52.236-4)

- B. Subsurface conditions have been developed by core borings and test pits. Logs of subsurface exploration are shown diagrammatically on drawings.
- C. A copy of the soil report will be made available for inspection by bidders upon request to the COR at the VA Medical Center, _____ and shall be considered part of the contract documents.
- D. Government does not guarantee that other materials will not be encountered nor that proportions, conditions or character of several materials will not vary from those indicated by explorations. Bidders are expected to examine site of work and logs of borings; and, after investigation, decide for themselves character of materials and make their bids accordingly. Upon proper application to Department of Veterans Affairs, bidders will be permitted to make subsurface explorations of their own at site.

1.12 PROFESSIONAL SURVEYING SERVICES

A registered professional land surveyor or registered civil engineer whose services are retained and paid for by the Contractor shall perform services specified herein and in other specification sections. The Contractor shall certify that the land surveyor or civil engineer is not one who is a regular employee of the Contractor, and that the land surveyor or civil engineer has no financial interest in this contract.

1.13 LAYOUT OF WORK

A. The Contractor shall lay out the work from Government established base lines and bench marks, indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at Contractor's own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through Contractor's negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

(FAR 52.236-17)

- B. Establish and plainly mark center lines for each building and corner of column lines and/or addition to each existing building, and such other lines and grades that are reasonably necessary to properly assure that location, orientation, and elevations established for each such structure and/or addition, roads, parking lots, are in accordance with lines and elevations shown on contract drawings.
- C. Following completion of general mass excavation and before any other permanent work is performed, establish and plainly mark (through use of appropriate batter boards or other means) sufficient additional survey control points or system of points as may be necessary to assure proper alignment, orientation, and grade of all major features of work. Survey shall include, but not be limited to, location of lines and grades of footings, exterior walls, center lines of columns in both directions, major utilities and elevations of floor slabs:
1. Such additional survey control points or system of points thus established shall be checked and certified by a registered land surveyor or registered civil engineer. Furnish such certification to the COR before any work (such as footings, floor slabs, columns, walls, utilities and other major controlling features) is placed.

- D. Whenever changes from contract drawings are made in line or grading requiring certificates, record such changes on a reproducible drawing bearing the registered land surveyor or registered civil engineer seal, and forward these drawings upon completion of work to COR.
- E. The Contractor shall perform the surveying and layout work of this and other articles and specifications in accordance with the provisions of Article "Professional Surveying Services".

1.14 AS-BUILT DRAWINGS

- A. The contractor shall maintain two full size sets of as-built drawings which will be kept current during construction of the project, to include all contract changes, modifications and clarifications and items/conditions that differ from the contract drawings
- B. All variations shall be shown in the same general detail as used in the contract drawings. To ensure compliance, as-built drawings shall be made available for the COR review, as often as requested.
- C. Contractor shall deliver two approved completed sets of as-built drawings in electronic format (scanned to PDF) to the COR within 15 calendar days after each completed phase and after the acceptance of the project by the COR.
- D. Paragraphs A, B, & C shall also apply to all shop drawings.

1.15 WARRANTY MANAGEMENT

- A. Warranty Management Plan: Develop a warranty management plan which contains information relevant to FAR 52.246-21 Warranty of Construction in at least 30 days before the planned pre-warranty conference, submit one set of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan must be in narrative form and contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesman, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was approved. Warranty information made available during the construction phase must be submitted to the Contracting Officer for approval prior to each monthly invoice for payment. Assemble approved information in a binder and turn over to the

Government upon acceptance of the work. The construction warranty period will begin on the date of the project acceptance and continue for the product warranty period. A joint 4 month and 9-month warranty inspection will be conducted, measured from time of acceptance, by the Contactor and the Contracting Officer. Include in the warranty management plan, but not limited to, the following:

1. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the company of the Contractor, subcontractors, manufacturers or suppliers involved.
2. Furnish with each warranty the name, address and telephone number of each of the guarantor's representatives nearest project location.
3. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers and for all commissioned systems such as fire protection and alarm systems, sprinkler systems and lightning protection systems, etc.
4. A list for each warranted equipment item, feature of construction or system indicating:
 - a. Name of item.
 - b. Model and serial numbers.
 - c. Location where installed.
 - d. Name and phone numbers of manufacturers and suppliers.
 - e. Name and phone numbers of manufacturers or suppliers.
 - f. Names, addresses and phone numbers of sources of spare parts.
 - g. Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have extended warranties must be indicated with separate warranty expiration dates.
 - h. Starting point and duration of warranty period.
 - i. Summary of maintenance procedures required to continue the warranty in force.

- j. Cross-reference to specific pertinent Operation and Maintenance manuals.
 - k. Organizations, names and phone numbers of persons to call for warranty service.
 - l. Typical response time and repair time expected for various warranted equipment.
5. The plans for attendance at the 4 and 9-month post construction warranty inspections conducted by the government.
6. Procedure and status of tagging of all equipment covered by extended warranties.
7. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- B. Performance Bond: The Performance Bond must remain effective throughout the construction period.
- 1. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.
 - 2. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the contractor's expenses, the Contracting Officer will have the right to recoup expenses from the bonding company.
 - 3. Following oral or written notification of required construction warranty repair work, the Contractor shall respond in a timely manner. Written verification will follow oral instructions. Failure to respond will be cause for the Contracting Officer to proceed against the Contractor.
- C. Pre-Warranty Conference: Prior to contract completion, and at a time designated by the Contracting Officer, the Contractor shall meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this section. Communication procedures for Contractor

notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty will be established/ reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contract will be located within the local service area of the warranted construction, be continuously available and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in conjunction with other portions of this provision.

D. Contractor's Response to Construction Warranty Service Requirements:

Following oral or written notification by the Contracting Officer, the Contractor shall respond to construction warranty service requirements in accordance with the "Construction Warranty Service Priority List" and the three categories of priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframe specified, the Government will perform the work and back charge the construction warranty payment item established.

1. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.
2. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.
3. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.
4. The "Construction Warranty Service Priority List" is as follows:

Code 1-Life Safety Systems

- a. Fire suppression systems.
- b. Fire alarm system(s).

Code 1-Air Conditioning Systems

- a. Air conditioning leak in part of the building, if causing damage.
- b. Air conditioning system not cooling properly.

Code 1 Doors

- a. Overhead doors not operational, causing a security, fire or safety problem.
- b. Interior, exterior personnel doors or hardware, not functioning properly, causing security, fire or safety problem.

Code 3-Doors

- a. Overhead doors not operational.
- b. Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical

- a. Power failure (entire area or any building operational after 1600 hours).
- b. Security lights.
- c. Smoke detectors.

Code 2-Electrical

- a. Power failure (no power to a room or part of building).
- b. Receptacles and lights not operational (in a room or part of building).

Code 3-Electrical

- a. Exterior lights not operational.

Code 1-Gas

- a. Leaks and pipeline breaks.

Code 1-Heat

- a. Power failure affecting heat.

Code 1-Plumbing

- a. Hot water heater failure.
- b. Leaking water supply pipes.

Code 2-Plumbing

- a. Flush valves not operating properly
- b. Fixture drain, supply line or any water pipe leaking.
- c. Toilet leaking at base.

Code 3- Plumbing

- a. Leaky faucets.

Code 3-Interior

- a. Floors damaged.
- b. Paint chipping or peeling.
- c. Casework damaged.

Code 1-Roof Leaks

- a. Damage to property is occurring.

Code 2-Water (Exterior)

- a. No water to facility.

Code 2-Water (Hot)

- a. No hot water in portion of building listed.

Code 3

- a. All work not listed above.

E. Warranty Tags: At the time of installation, tag each warranted item with a durable, oil and water-resistant tag approved by the Contracting Officer. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also submit two record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain

blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	
Contract number	
Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	

1.16 USE OF ROADWAYS

- A. For hauling, use only established public roads and roads on Medical Center property and, when authorized by the COR, such temporary roads which are necessary in the performance of contract work. Temporary roads shall be constructed and restoration performed by the Contractor at Contractor's expense. When necessary to cross curbing, sidewalks, or similar construction, they must be protected by well-constructed bridges.
- B. When new permanent roads are to be a part of this contract, Contractor may construct them immediately for use to facilitate building operations. These roads may be used by all who have business thereon within zone of building operations.
- C. When certain buildings (or parts of certain buildings) are required to be completed in advance of general date of completion, all roads leading

thereto must be completed and available for use at time set for completion of such buildings or parts thereof.

1.17 RESIDENT ENGINEER'S FIELD OFFICE (NOT USED)

1.18 TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Use of new installed mechanical and electrical equipment to provide heat, ventilation, plumbing, light and power will be permitted subject to written approval and compliance with the following provisions:
1. Permission to use each unit or system must be given by COR in writing. If the equipment is not installed and maintained in accordance with the written agreement and following provisions, the COR will withdraw permission for use of the equipment.
 2. Electrical installations used by the equipment shall be completed in accordance with the drawings and specifications to prevent damage to the equipment and the electrical systems, i.e. transformers, relays, circuit breakers, fuses, conductors, motor controllers and their overload elements shall be properly sized, coordinated and adjusted. Installation of temporary electrical equipment or devices shall be in accordance with NFPA 70, National Electrical Code, (2014 Edition), Article 590, *Temporary Installations*. Voltage supplied to each item of equipment shall be verified to be correct and it shall be determined that motors are not overloaded. The electrical equipment shall be thoroughly cleaned before using it and again immediately before final inspection including vacuum cleaning and wiping clean interior and exterior surfaces.
 3. Units shall be properly lubricated, balanced, and aligned. Vibrations must be eliminated.
 4. Automatic temperature control systems for preheat coils shall function properly and all safety controls shall function to prevent coil freeze-up damage.
 5. The air filtering system utilized shall be that which is designed for the system when complete, and all filter elements shall be replaced at completion of construction and prior to testing and balancing of system.
 6. All components of heat production and distribution system, metering equipment, condensate returns, and other auxiliary facilities used in

temporary service shall be cleaned prior to use; maintained to prevent corrosion internally and externally during use; and cleaned, maintained and inspected prior to acceptance by the Government. Boilers, pumps, feedwater heaters and auxiliary equipment must be operated as a complete system and be fully maintained by operating personnel. Boiler water must be given complete and continuous chemical treatment.

- B. Prior to final inspection, the equipment or parts used which show wear and tear beyond normal, shall be replaced with identical replacements, at no additional cost to the Government.
- C. This paragraph shall not reduce the requirements of the mechanical and electrical specifications sections.
- D. Any damage to the equipment or excessive wear due to prolonged use will be repaired replaced by the contractor at the contractor's expense.

1.19 TEMPORARY USE OF EXISTING ELEVATORS (NOT USED)

1.20 TEMPORARY USE OF NEW ELEVATORS (NOT USED)

1.21 TEMPORARY TOILETS (NOT USED)

1.22 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, in compliance with code and as 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 and repair restore the infrastructure as required.
- 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 as per code. 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 discretion) of use of water from Medical Center's system.
- G. Fuel: Natural and LP gas and burner fuel oil required for boiler cleaning, normal initial boiler-burner setup and adjusting, and for performing the specified boiler tests will be furnished by the Government. Fuel required for prolonged boiler-burner setup, adjustments, or modifications due to improper design or operation of boiler, burner, or control devices shall be furnished and paid by the Contractor at Contractor's expense.

1.23 NEW TELEPHONE EQUIPMENT (NOT USED)

1.24 TESTS

- A. As per specification section 23 05 93 the contractor shall provide a written testing and commissioning plan complete with component level,

equipment level, sub-system level and system level breakdowns. The plan will provide a schedule and a written sequence of what will be tested, how and what the expected outcome will be. This document will be submitted for approval prior to commencing work. The contractor shall document the results of the approved plan and submit for approval with the as built documentation.

- B. 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.
- C. 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.
- D. Mechanical and electrical systems shall be balanced, controlled and coordinated. A system is defined as the entire system 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 system which involves several components of different disciplines is a boiler installation. Efficient and acceptable boiler operation depends upon the coordination and proper operation of fuel, combustion air, controls, steam, feedwater, condensate and other related components.
- E. All related components as defined above shall be functioning when any system component is tested. Tests shall be completed within a reasonably period of time during which operating and environmental conditions remain reasonably constant and are typical of the design conditions.
- F. 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.

1.25 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 training 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 contractor shall submit a course outline with associated

material to the COR for review and approval prior to scheduling training to ensure the subject matter covers the expectations of the VA and the contractual requirements. 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.

1.26 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. Contractor shall be prepared to receive this equipment from Government and store or place such equipment not less than 90 days before Completion Date of project.
- 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.

1.27 RELOCATED EQUIPMENT

- A. Contractor shall disconnect, dismantle as necessary, remove and reinstall in new location, all existing equipment indicated by symbol "R" or otherwise shown to be relocated by the Contractor.
- B. Perform relocation of such equipment or items at such times and in such a manner as directed by the COR.
- C. Suitably cap existing service lines, such as steam, condensate return, water, drain, gas, air, vacuum and/or electrical, at the main whenever such lines are disconnected from equipment to be relocated. Remove abandoned lines in finished areas and cap as specified herein before under paragraph "Abandoned Lines".
- D. Provide all mechanical and electrical service connections, fittings, fastenings and any other materials necessary for assembly and installation of relocated equipment; and leave such equipment in proper operating condition.
- E. All service lines such as noted above for relocated equipment shall be in place at point of relocation ready for use before any existing equipment is disconnected. Make relocated existing equipment ready for operation or use immediately after reinstallation.

1.28 STORAGE SPACE FOR DEPARTMENT OF VETERANS AFFAIRS EQUIPMENT

1.29 CONSTRUCTION SIGN

- A. Provide a Construction Sign where directed by the COR. All wood members shall be of framing lumber. Cover sign frame with 0.7 mm (24 gage) galvanized sheet steel nailed securely around edges and on all bearings. Provide three 100 by 100 mm (4 inch by 4 inch) posts (or equivalent round posts) set 1200 mm (four feet) into ground. Set bottom of sign level at 900 mm (three feet) above ground and secure to posts with through bolts.

Make posts full height of sign. Brace posts with 50 x 100 mm (two by four inch) material as directed.

- B. Paint all surfaces of sign and posts two coats of white gloss paint. Border and letters shall be of black gloss paint, except project title which shall be blue gloss paint.
- C. Maintain sign and remove it when directed by the COR.
- D. Detail Drawing of construction sign showing required legend and other characteristics of sign is made a part of this specification.

1.30 SAFETY SIGN

- A. Provide a Safety Sign where directed by COR. Face of sign shall be 19 mm (3/4 inch) thick exterior grade plywood. Provide two 100 mm by 100 mm (four by four inch) posts extending full height of sign and 900 mm (three feet) into ground. Set bottom of sign level at 1200 mm (four feet) above ground.
- B. Paint all surfaces of Safety Sign and posts with one prime coat and two coats of white gloss paint. Letters and design shall be painted with gloss paint of colors noted.
- C. Maintain sign and remove it when directed by COR.
- D. Standard Detail Drawing Number SD10000-02 (Found on VA TIL) of safety sign showing required legend and other characteristics of sign is made a part of this specification.
- E. Post the number of accident free days on a daily basis.

1.31 PHOTOGRAPHIC DOCUMENTATION (NOT USED)

1.32 FINAL ELEVATION DIGITAL IMAGES (NOT USED)

1.33 HISTORIC PRESERVATION

- A. Where the Contractor or any of the Contractor's employees, prior to, or during the construction work, are advised of or discover any possible archeological, historical and/or cultural resources, the Contractor shall immediately notify the COR verbally, and then with a written follow up.

1.34 VA TRIRIGA CPMS (NOT USED)

- - - E N D - - -

SECTION 01 32 16.15
PROJECT SCHEDULES
(SMALL PROJECTS - DESIGN/BID/BUILD)

PART 1- GENERAL

1.1 DESCRIPTION:

- A. The Contractor shall develop a 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).

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 (COR).
- 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 be responsible for the accurate and timely submittal of the updated project schedule.
- 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 hard copies of the interim schedule on sheets of 11 x 17 paper and an electronic file. 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.

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 852.232 - Article 70 Without NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION).
- 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 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 workdays 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 workdays.
 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: 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 an application and certificate for payment using VA Form 10-6001a 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 852.232 - Article 70 Without NAS-CPM for (PAYMENTS UNDER FIXED PRICE CONSTRUCTION). 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 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 workdays 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 resident engineer 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 resident engineer. 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 resident engineer 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 schedule, the VA, the General Contractor 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 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. Schedule 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 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 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 workdays) 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). The Contractor

shall include, as a part of each change order proposal, a sketch showing all schedule 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****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This specification defines the general requirements and procedures for submittals. A submittal is information submitted for VA review to establish compliance with the contract documents.
- B. Detailed submittal requirements are found in the technical sections of the contract specifications. The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective technical specifications at no additional cost to the government.
- C. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor's expense.

1.2 DEFINITIONS

- A. Samples: Physical examples of materials, equipment, or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project. Field samples and mock-ups constructed to establish standards by which the ensuing work can be judged.
- B. Design Data: Calculations, mix designs, analyses, or other data pertaining to a part of work.
- C. Test Reports: Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

- D. Certificates: Document required of Contractor, or of a manufacturer, supplier, installer, or subcontractor through Contractor. The purpose is to document procedures, acceptability of methods, or personnel qualifications for a portion of the work.
- E. Manufacturer's Instructions: Pre-printed material describing installation of a product, system, or material, including special notices and MSDS concerning impedances, hazards, and safety precautions.
- F. Manufacturer's Field Reports: Documentation of the testing and verification actions taken by manufacturer's representative at the job site on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must indicate whether the material, product, or system has passed or failed the test.
- G. Operation and Maintenance Data: Manufacturer data that is required to operate, maintain, troubleshoot, and repair equipment, including manufacturer's help, parts list, and product line documentation. This data shall be incorporated in an operations and maintenance manual.
- H. Closeout Submittals: Documentation necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a phase of construction on a multi-phase contract.

1.3 SUBMITTAL REGISTER

- A. The submittal register will list items of equipment and materials for which submittals are required by the specifications. This list may not be all inclusive and additional submittals may be required by the specifications. The Contractor is not relieved from supplying submittals required by the contract documents but which have been omitted from the submittal register.
- B. The submittal register will serve as a scheduling document for submittals and will be used to control submittal actions throughout the contract period.
- C. The VA will provide the initial submittal register in electronic format. Thereafter, the Contractor shall track all submittals by maintaining a complete list, including completion of all data columns,

including dates on which submittals are received and returned by the VA.

- D. The Contractor shall update the submittal register as submittal actions occur and maintain the submittal register at the project site until final acceptance of all work by Contracting Officer.
- E. The Contractor shall submit formal monthly updates to the submittal register in electronic format. Each monthly update shall document actual submission and approval dates for each submittal.

1.4 SUBMITTAL SCHEDULING

- A. Submittals are to be scheduled, submitted, reviewed, and approved prior to the acquisition of the material or equipment.
- B. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow time for potential resubmittal.
- C. No delay costs or time extensions will be allowed for time lost in late submittals or resubmittals.
- D. All submittals are required to be approved prior to the start of the specified work activity.

1.5 SUBMITTAL PREPARATION

- A. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.
- B. Collect required data for each specific material, product, unit of work, or system into a single submittal. Prominently mark choices, options, and portions applicable to the submittal. Partial submittals will not be accepted for expedition of construction effort. Submittal will be returned without review if incomplete.
- C. If available product data is incomplete, provide Contractor-prepared documentation to supplement product data and satisfy submittal requirements.
- D. All irrelevant or unnecessary data shall be removed from the submittal to facilitate accuracy and timely processing. Submittals that contain the excessive amount of irrelevant or unnecessary data will be returned with review.
- E. Provide a transmittal form for each submittal with the following information:

1. Project title, location, and number.
 2. Construction contract number.
 3. Date of the drawings and revisions.
 4. Name, address, and telephone number of subcontractor, supplier, manufacturer, and any other subcontractor associated with the submittal.
 5. List paragraph number of the specification section and sheet number of the contract drawings by which the submittal is required.
 6. When a resubmission, add alphabetic suffix on submittal description. For example, submittal 18 would become 18A, to indicate resubmission.
 7. Product identification and location in project.
- F. The Contractor is responsible for reviewing and certifying that all submittals are in compliance with contract requirements before submitting for VA review. Proposed deviations from the contract requirements are to be clearly identified. All deviations submitted must include a side by side comparison of item being proposed against item specified. Failure to point out deviations will result in the VA requiring removal and replacement of such work at the Contractor's expense.
- G. Stamp, sign, and date each submittal transmittal form indicating action taken.
- H. Stamp used by the Contractor on the submittal transmittal form to certify that the submittal meets contract requirements is to be similar to the following:

CONTRACTOR
(Firm Name)
_____Approved
_____Approved with corrections as noted on submittal data and/or attached sheets(s)
SIGNATURE: _____
TITLE: _____
DATE: _____

1.6 SUBMITTAL FORMAT AND TRANSMISSION

- A. Provide submittals in electronic format, except for material samples. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer.
- B. Compile the electronic submittal file as a single, complete document. Name the electronic submittal file specifically according to its contents.
- C. Electronic files must be of sufficient quality that all information is legible. Generate PDF files from original documents so that the text included in the PDF file is both searchable and can be copied. If documents are scanned, Optical Character Resolution (OCR) routines are required.

- D. E-mail electronic submittal documents smaller than 5MB in size to e-mail addresses as directed by the Contracting Officer.
- E. Provide electronic documents over 5MB through an electronic FTP file sharing system. Confirm that the electronic FTP file sharing system can be accessed from the VA computer network. The Contractor is responsible for setting up, providing, and maintaining the electronic FTP file sharing system for the construction contract period of performance.
- F. Provide hard copies of submittals when requested by the Contracting Officer. Up to 3 additional hard copies of any submittal may be requested at the discretion of the Contracting Officer, at no additional cost to the VA.

1.7 SAMPLES

- A. Submit two sets of physical samples showing range of variation, for each required item.
- B. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified.
- C. When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.
- D. Before submitting samples, the Contractor is to ensure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.
- E. The VA reserves the right to disapprove any material or equipment which previously has proven unsatisfactory in service.
- F. Physical samples supplied maybe requested back for use in the project after reviewed and approved.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit data specified for a given item within 30 calendar days after the item is delivered to the contract site.
- B. In the event the Contractor fails to deliver O&M Data within the time limits specified, the Contracting Officer may withhold from progress payments 50 percent of the price of the item with which such O&M Data are applicable.

1.9 TEST REPORTS

SRE may require specific test after work has been installed or completed which could require contractor to repair test area at no additional cost to contract.

1.10 VA REVIEW OF SUBMITTALS AND RFIS

- A. The VA will review all submittals for compliance with the technical requirements of the contract documents. The Architect-Engineer for this project will assist the VA in reviewing all submittals and determining contractual compliance. Review will be only for conformance with the applicable codes, standards and contract requirements.
- B. Period of review for submittals begins when the VA COR receives submittal from the Contractor.
- C. Period of review for each resubmittal is the same as for initial submittal.
- D. VA review period is 15 working days for submittals.
- E. VA review period is 10 working days for RFIs.
- F. The VA will return submittals to the Contractor with the following notations:
 - 1. "Approved": authorizes the Contractor to proceed with the work covered.
 - 2. "Approved as noted": authorizes the Contractor to proceed with the work covered provided the Contractor incorporates the noted comments and makes the noted corrections.
 - 3. "Disapproved, revise and resubmit": indicates noncompliance with the contract requirements or that submittal is incomplete. Resubmit with appropriate changes and corrections. No work shall proceed for this item until resubmittal is approved.
 - 4. "Not reviewed": indicates submittal does not have evidence of being reviewed and approved by Contractor or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals after taking appropriate action.

1.11 APPROVED SUBMITTALS

- A. The VA approval of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing, and other information are satisfactory.
- B. VA approval of a submittal does not relieve the Contractor of the responsibility for any error which may exist. The Contractor is responsible for fully complying with all contract requirements and the satisfactory construction of all work, including the need to check, confirm, and coordinate the work of all subcontractors for the project. Non-compliant material incorporated in the work will be removed and replaced at the Contractor's expense.
- C. After submittals have been approved, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.
- D. Retain a copy of all approved submittals at project site, including approved samples.

1.12 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

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**SECTION 01 35 26
SAFETY REQUIREMENTS**

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**SECTION 01 35 26
SAFETY REQUIREMENTS**

1.1 APPLICABLE PUBLICATIONS:

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

B. American Society of Safety Engineers (ASSE):

A10.1-2011Pre-Project & Pre-Task Safety and Health
Planning

A10.34-2012Protection of the Public on or Adjacent to
Construction Sites

A10.38-2013Basic Elements of an Employer's Program to
Provide a Safe and Healthful Work Environment
American National Standard Construction and
Demolition Operations

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

E84-2013Surface Burning Characteristics of Building
Materials

D. The Facilities Guidelines Institute (FGI):

FGI Guidelines-2010Guidelines for Design and Construction of Healthcare
Facilities

E. National Fire Protection Association (NFPA):

10-2013Standard for Portable Fire Extinguishers

30-2012Flammable and Combustible Liquids Code

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

70-2014National Electrical Code

70B-2013Recommended Practice for Electrical Equipment
Maintenance

70E-2015Standard for Electrical Safety in the Workplace

99-2012Health Care Facilities Code

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

F. The Joint Commission (TJC)

TJC ManualComprehensive Accreditation and Certification
Manual

G. U.S. Nuclear Regulatory Commission

10 CFR 20Standards for Protection Against Radiation

H. U.S. Occupational Safety and Health Administration (OSHA):

29 CFR 1904Reporting and Recording Injuries & Illnesses

29 CFR 1910Safety and Health Regulations for General
Industry

29 CFR 1926Safety and Health Regulations for Construction
Industry

CPL 2-0.124Multi-Employer Citation Policy

I. VHA Directive 2005-007

1.2 DEFINITIONS:

A. Critical Lift. A lift with the hoisted load exceeding 75% of the crane's maximum capacity; lifts made out of the view of the operator (blind picks); lifts involving two or more cranes; personnel being hoisted; and special hazards such as lifts over occupied facilities, loads lifted close to power-lines, and lifts in high winds or where other adverse environmental conditions exist; and any lift which the crane operator believes is critical.

B. OSHA "Competent Person" (CP). One who is capable of identifying existing and predictable hazards in the surroundings and working conditions which

are unsanitary, hazardous or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them (see 29 CFR 1926.32(f)).

- C. "Qualified Person" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.
- D. High Visibility Accident. Any mishap which may generate publicity or high visibility.
- E. Accident/Incident Criticality Categories:

No impact - near miss incidents that should be investigated but are not required to be reported to the VA.

Minor incident/impact - incidents that require first aid or result in minor equipment damage (less than \$5000). These incidents must be investigated but are not required to be reported to the VA.

Moderate incident/impact - Any work-related injury or illness that results in:

1. Days away from work (any time lost after day of injury/illness onset).
2. Restricted work.
3. Transfer to another job.
4. Medical treatment beyond first aid.
5. Loss of consciousness.
6. A significant injury or illness diagnosed by a physician or other licensed health care professional, even if it did not result in (1) through (5) above or,
7. any incident that leads to major equipment damage (greater than \$5000).

These incidents must be investigated and are required to be reported to the VA.

Major incident/impact - Any mishap that leads to fatalities, hospitalizations, amputations, and losses of an eye as a result of contractors' activities. Or any incident which leads to major property damage (greater than \$20,000) and/or may generate publicity or high visibility. These incidents must be investigated and are required to be reported to the VA as soon as practical, but not later than 2 hours after the incident.

- F. Medical Treatment. Treatment administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does not include first aid treatment even through provided by physician or registered personnel.

1.3 REGULATORY REQUIREMENTS:

- A. In addition to the detailed requirements included in the provisions of this contract, comply with 29 CFR 1926, comply with 29 CFR 1910 as incorporated by reference within 29 CFR 1926, comply with ASSE A10.34, and all applicable federal, state, and local laws, ordinances, criteria, rules and regulations . Submit matters of interpretation of standards for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern except with specific approval and acceptance by the Contracting Officer Representative (COR).

1.4 ACCIDENT PREVENTION PLAN (APP):

- A. The APP (aka Construction Safety & Health Plan) shall interface with the Contractor's overall safety and health program. Include any portions of the Contractor's overall safety and health program referenced in the APP in the applicable APP element and ensure it is site-specific. The Government considers the Prime Contractor to be the "controlling authority" for all worksite safety and health of each subcontractor(s). Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent

one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.

B. The APP shall be prepared as follows:

1. Written in English by a qualified person who is employed by the Prime Contractor articulating the specific work and hazards pertaining to the contract (model language can be found in ASSE A10.33). Specifically articulating the safety requirements found within these VA contract safety specifications.
2. Address both the Prime Contractors and the subcontractors work operations.
3. State measures to be taken to control hazards associated with materials, services, or equipment provided by suppliers.
4. Address all the elements/sub-elements and in order as follows:
 - a. **SIGNATURE SHEET.** Title, signature, and phone number of the following:
 1. Plan preparer (Qualified Person such as corporate safety staff person or contracted Certified Safety Professional with construction safety experience).
 2. Plan approver (company/corporate officers authorized to obligate the company).
 3. Plan concurrence (e.g., Chief of Operations, Corporate Chief of Safety, Corporate Industrial Hygienist, project manager or superintendent, project safety professional). Provide concurrence of other applicable corporate and project personnel (Contractor).
 - b. **BACKGROUND INFORMATION.** List the following:
 1. Contractor.
 2. Contract number.

3. Project name.
 4. Brief project description, description of work to be performed, and location; phases of work anticipated (these will require an AHA).
- c. **STATEMENT OF SAFETY AND HEALTH POLICY.** Provide a copy of current corporate/company Safety and Health Policy Statement, detailing commitment to providing a safe and healthful workplace for all employees. The Contractor's written safety program goals, objectives, and accident experience goals for this contract should be provided.
- d. **RESPONSIBILITIES AND LINES OF AUTHORITIES.** Provide the following:
1. A statement of the employer's ultimate responsibility for the implementation of his SOH program.
 2. Identification and accountability of personnel responsible for safety at both corporate and project level. Contracts specifically requiring safety or industrial hygiene personnel shall include a copy of their resumes.
 3. The names of Competent and/or Qualified Person(s) and proof of competency/qualification to meet specific OSHA Competent/Qualified Person(s) requirements must be attached.
 4. Requirements that no work shall be performed unless a designated competent person is present on the job site.
 5. Requirements for pre-task Activity Hazard Analysis (AHAs).
 6. Lines of authority.
 7. Policies and procedures regarding noncompliance with safety requirements (to include disciplinary actions

for violation of safety requirements) should be identified.

e. **SUBCONTRACTORS AND SUPPLIERS.** If applicable, provide procedures for coordinating SOH activities with other employers on the job site:

1. Identification of subcontractors and suppliers (if known).
2. Safety responsibilities of subcontractors and suppliers.

f. **TRAINING.**

1. Site-specific SOH orientation training at the time of initial hire or assignment to the project for every employee before working on the project site is required.
2. Mandatory training and certifications that are applicable to this project (e.g., explosive actuated tools, crane operator, rigger, crane signal person, fall protection, electrical lockout/NFPA 70E, machine/equipment lockout, confined space, etc.) and any requirements for periodic retraining/recertification are required.
3. Procedures for ongoing safety and health training for supervisors and employees shall be established to address changes in site hazards/conditions.
4. OSHA 10-hour training is required for all workers on site and the OSHA 30-hour training is required for Trade Competent Persons (CPs)

g. **SAFETY AND HEALTH INSPECTIONS.**

1. Specific assignment of responsibilities for a minimum daily job site safety and health inspection during periods of work activity: Who will conduct (e.g.,

"Site Safety and Health CP"), proof of inspector's training/qualifications, when inspections will be conducted, procedures for documentation, deficiency tracking system, and follow-up procedures.

2. Any external inspections/certifications that may be required (e.g., contracted CSP or CSHT)

h. **ACCIDENT/INCIDENT INVESTIGATION & REPORTING.** The Contractor shall conduct mishap investigations of all Moderate and Major as well as all High Visibility Incidents. The APP shall include accident/incident investigation procedure and identify person(s) responsible to provide the following to the COR or Government Designated Authority:

1. Exposure data (man-hours worked).
2. Accident investigation reports.
3. Project site injury and illness logs.

i. **PLANS (PROGRAMS, PROCEDURES) REQUIRED.** Based on a risk assessment of contracted activities and on mandatory OSHA compliance programs, the Contractor shall address all applicable occupational, patient, and public safety risks in site-specific compliance and accident prevention plans. These Plans shall include but are not be limited to procedures for addressing the risks associates with the following:

1. Emergency response.
2. Contingency for severe weather.
3. Fire Prevention.
4. Medical Support.
5. Posting of emergency telephone numbers.
6. Prevention of alcohol and drug abuse.

7. Site sanitation (housekeeping, drinking water, toilets).
8. Night operations and lighting.
9. Hazard communication program.
10. Welding/Cutting "Hot" work.
11. Electrical Safe Work Practices (Electrical LOTO/NFPA 70E).
12. General Electrical Safety.
13. Hazardous energy control (Machine LOTO).
14. Site-Specific Fall Protection & Prevention.
- 15.
16. Asbestos abatement.
17. Lead abatement.
18. Respiratory protection.
19. Health hazard control program.
20.);
21. Demolition plan (to include engineering survey).
22. Public (Mandatory compliance with ANSI/ASSE A10.34-2012).

C. Submit the APP to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP.

D. Once accepted by the COR, the APP and attachments will be enforced as part of the contract. Disregarding the provisions of this contract or the accepted APP will be cause for stopping of work, at the discretion

of the Contracting Officer in accordance with FAR Clause 52.236-13, *Accident Prevention*, until the matter has been rectified.

- E. Once work begins, changes to the accepted APP shall be made with the knowledge and concurrence of the COR. project superintendent, project overall designated OSHA Competent Person, and COR. Should any severe hazard exposure, i.e. imminent danger, become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate/remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public and the environment.

1.5 ACTIVITY HAZARD ANALYSES (AHAS) :

- A. AHAs are also known as Job Hazard Analyses, Job Safety Analyses, and Activity Safety Analyses. Before beginning each work activity involving a type of work presenting hazards not experienced in previous project operations or where a new work crew or sub-contractor is to perform the work, the Contractor(s) performing that work activity shall prepare an AHA (Example electronic AHA forms can be found on the US Army Corps of Engineers web site)
- B. AHAs shall define the activities being performed and identify the work sequences, the specific anticipated hazards, site conditions, equipment, materials, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level of risk.
- C. Work shall not begin until the AHA for the work activity has been accepted by the COR or Contracting Officer and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.
 - 1. The names of the Competent/Qualified Person(s) required for a particular activity (for example, excavations, scaffolding, fall protection, other activities as specified by OSHA and/or other State and Local agencies) shall be identified and included in the AHA. Certification of their competency/qualification shall be

submitted to the Government Designated Authority (GDA) for acceptance prior to the start of that work activity.

2. The AHA shall be reviewed and modified as necessary to address changing site conditions, operations, or change of competent/qualified person(s).
 - a. If more than one Competent/Qualified Person is used on the AHA activity, a list of names shall be submitted as an attachment to the AHA. Those listed must be Competent/Qualified for the type of work involved in the AHA and familiar with current site safety issues.
 - b. If a new Competent/Qualified Person (not on the original list) is added, the list shall be updated (an administrative action not requiring an updated AHA). The new person shall acknowledge in writing that he or she has reviewed the AHA and is familiar with current site safety issues.
3. Submit AHAs to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES for review at least 15 calendar days prior to the start of each phase. Subsequent AHAs as shall be formatted as amendments to the APP. The analysis should be used during daily inspections to ensure the implementation and effectiveness of the activity's safety and health controls.
4. The AHA list will be reviewed periodically (at least monthly) at the Contractor supervisory safety meeting and updated as necessary when procedures, scheduling, or hazards change.
5. Develop the activity hazard analyses using the project schedule as the basis for the activities performed. All activities listed on the project schedule will require an AHA. The AHAs will be developed by the contractor, supplier, or subcontractor and provided to the prime contractor for review and approval and then submitted to the COR.

1.6 PRECONSTRUCTION CONFERENCE:

- A. Contractor representatives who have a responsibility or significant role in implementation of the accident prevention program, as required by 29 CFR 1926.20(b)(1), on the project shall attend the preconstruction conference to gain a mutual understanding of its implementation. This includes the project superintendent, subcontractor superintendents, and any other assigned safety and health professionals.
- B. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the contract. This list of proposed AHAs will be reviewed at the conference and an agreement will be reached between the Contractor and the Contracting Officer's representative as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, review, and acceptance of AHAs to preclude project delays.
- C. Deficiencies in the submitted APP will be brought to the attention of the Contractor within 14 days of submittal, and the Contractor shall revise the plan to correct deficiencies and re-submit it for acceptance. Do not begin work until there is an accepted APP.

1.7 "SITE SAFETY AND HEALTH OFFICER" (SSHO) AND "COMPETENT PERSON" (CP):

- A. The Prime Contractor shall designate a minimum of one SSHO at each project site that will be identified as the SSHO to administer the Contractor's safety program and government-accepted Accident Prevention Plan. Each subcontractor shall designate a minimum of one CP in compliance with 29 CFR 1926.20 (b)(2) that will be identified as a CP to administer their individual safety programs.
- B. Further, all specialized Competent Persons for the work crews will be supplied by the respective contractor as required by 29 CFR 1926 (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations).

- C. These Competent Persons can have collateral duties as the subcontractor's superintendent and/or work crew lead persons as well as fill more than one specialized CP role (i.e. Asbestos, Electrical, Cranes, & Derricks, Demolition, Fall Protection, Fire Safety/Life Safety, Ladder, Rigging, Scaffolds, and Trenches/Excavations). However, the SSHO must be a separate qualified individual from the Prime Contractor's Superintendent and/or Quality Control Manager with duties only as the SSHO.
- D. The SSHO or an equally qualified Designated Representative/alternate will maintain a presence on the site during construction operations in accordance with FAR Clause 52.236-6: *Superintendence by the Contractor*. CPs will maintain presence during their construction activities in accordance with above mentioned clause. A listing of the designated SSHO and all known CPs shall be submitted prior to the start of work as part of the APP with the training documentation and/or AHA as listed in Section 1.8 below.
- E. The repeated presence of uncontrolled hazards during a contractor's work operations will result in the designated CP as being deemed incompetent and result in the required removal of the employee in accordance with FAR Clause 52.236-5: Material and Workmanship, Paragraph (c).

1.8 TRAINING:

- A. The designated Prime Contractor SSHO must meet the requirements of all applicable OSHA standards and be capable (through training, experience, and qualifications) of ensuring that the requirements of 29 CFR 1926.16 and other appropriate Federal, State and local requirements are met for the project. As a minimum the SSHO must have completed the OSHA 30-hour Construction Safety class and have five (5) years of construction industry safety experience or three (3) years if he/she possesses a Certified Safety Professional (CSP) or certified Construction Safety and Health Technician (CSHT) certification or have a safety and health degree from an accredited university or college.
- B. All designated CPs shall have completed the OSHA 30-hour Construction Safety course within the past 5 years.

- C. In addition to the OSHA 30 Hour Construction Safety Course, all CPs with high hazard work operations such as operations involving asbestos, electrical, cranes, demolition, work at heights/fall protection, fire safety/life safety, ladder, rigging, scaffolds, and trenches/excavations shall have a specialized formal course in the hazard recognition & control associated with those high hazard work operations. Documented "repeat" deficiencies in the execution of safety requirements will require retaking the requisite formal course.
- D. All other construction workers shall have the OSHA 10-hour Construction Safety Outreach course and any necessary safety training to be able to identify hazards within their work environment.
- E. Submit training records associated with the above training requirements to the COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES 15 calendar days prior to the date of the preconstruction conference for acceptance.
- F. Prior to any worker for the contractor or subcontractors beginning work, they shall undergo a safety briefing provided by the SSHO or his/her designated representative. As a minimum, this briefing shall include information on the site-specific hazards, construction limits, VAMC safety guidelines, means of egress, break areas, work hours, locations of restrooms, use of VAMC equipment, emergency procedures, accident reporting etc... Documentation shall be provided to the COR that individuals have undergone contractor's safety briefing.
- G. Ongoing safety training will be accomplished in the form of weekly documented safety meeting.

1.9 INSPECTIONS:

- A. The SSHO shall conduct frequent and regular safety inspections (daily) of the site and each of the subcontractors CPs shall conduct frequent and regular safety inspections (daily) of their work operations as required by 29 CFR 1926.20(b)(2). Each week, the SSHO shall conduct a formal documented inspection of the entire construction areas with the subcontractors' "Trade Safety and Health CPs" present in their work

areas. Coordinate with, and report findings and corrective actions weekly to COR.

- B. A Certified Safety Professional (CSP) with specialized knowledge in construction safety or a certified Construction Safety and Health Technician (CSHT) shall randomly conduct a monthly site safety inspection. The CSP or CSHT can be a corporate safety professional or independently contracted. The CSP or CSHT will provide their certificate number on the required report for verification as necessary.
1. Results of the inspection will be documented with tracking of the identified hazards to abatement.
 2. The COR will be notified immediately prior to start of the inspection and invited to accompany the inspection.
 3. Identified hazard and controls will be discussed to come to a mutual understanding to ensure abatement and prevent future reoccurrence.
 4. A report of the inspection findings with status of abatement will be provided to the COR within one week of the onsite inspection.

1.10 ACCIDENTS, OSHA 300 LOGS, AND MAN-HOURS:

- A. The prime contractor shall establish and maintain an accident reporting, recordkeeping, and analysis system to track and analyze all injuries and illnesses, high visibility incidents, and accidental property damage (both government and contractor) that occur on site. Notify the COR as soon as practical, but no more than four hours after any accident meeting the definition of a Moderate or Major incidents, High Visibility Incidents, , or any weight handling and hoisting equipment accident. Within notification include contractor name; contract title; type of contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (to include type of construction equipment used, PPE used, etc.). Preserve the conditions

and evidence on the accident site until the COR determines whether a government investigation will be conducted.

- B. Conduct an accident investigation for all Minor, Moderate and Major incidents as defined in paragraph DEFINITIONS, and property damage accidents resulting in at least \$20,000 in damages, to establish the root cause(s) of the accident. Complete the VA Form 2162 (or equivalent), and provide the report to the COR within 5 calendar days of the accident. The COR will provide copies of any required or special forms.
- C. A summation of all man-hours worked by the contractor and associated sub-contractors for each month will be reported to the COR monthly.
- D. A summation of all Minor, Moderate, and Major incidents experienced on site by the contractor and associated sub-contractors for each month will be provided to the COR monthly. The contractor and associated sub-contractors' OSHA 300 logs will be made available to the COR as requested.

1.11 PERSONAL PROTECTIVE EQUIPMENT (PPE) :

- A. PPE is governed in all areas by the nature of the work the employee is performing. For example, specific PPE required for performing work on electrical equipment is identified in NFPA 70E, Standard for Electrical Safety in the Workplace.
- B. Mandatory PPE includes:
 - 1. Hard Hats - unless written authorization is given by the COR in circumstances of work operations that have limited potential for falling object hazards such as during finishing work or minor remodeling. With authorization to relax the requirement of hard hats, if a worker becomes exposed to an overhead falling object hazard, then hard hats would be required in accordance with the OSHA regulations.
 - 2. Safety glasses - unless written authorization is given by the COR in circumstances of no eye hazards, appropriate safety glasses meeting the ANSI Z.87.1 standard must be worn by each person on site.

3. Appropriate Safety Shoes - based on the hazards present, safety shoes meeting the requirements of ASTM F2413-11 shall be worn by each person on site unless written authorization is given by the COR in circumstances of no foot hazards.
4. Hearing protection - Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks.

1.12 INFECTION CONTROL

- A. Infection Control is critical in all medical center facilities. Interior construction activities causing disturbance of existing dust, or creating new dust, must be conducted within ventilation-controlled areas that minimize the flow of airborne. Exterior construction activities causing disturbance of soil or creates dust in some other manner must be controlled.
- B. An AHA associated with infection control will be performed by VA personnel in accordance with FGI Guidelines (i.e. Infection Control Risk Assessment (ICRA)). The ICRA procedure found on the American Society for Healthcare Engineering (ASHE) website will be utilized. Risk classifications of Class II or lower will require approval by the COR before beginning any construction work. Risk classifications of Class III or higher will require a permit before beginning any construction work. Infection Control permits will be issued by the COR or by the person the COR designates. The Infection Control Permits will be posted outside the appropriate construction area. More than one permit may be issued for a construction project if the work is located in separate areas requiring separate classes. The primary project scope area for this project will be determined by the COR, however, work outside the primary project scope area may vary. The required infection control precautions with each class are as follows:

1. Class I requirements:

- a. During Construction Work:

1. Notify the COR.

2. Execute work by methods to minimize raising dust from construction operations.
3. Ceiling tiles: Immediately replace a ceiling tiles displaced for visual inspection.

b. Upon Completion:

1. Clean work area upon completion of task
2. Notify the COR.

2. Class II requirements:

a. During Construction Work:

1. Notify the COR
2. Provide active means to prevent airborne dust from dispersing into atmosphere such as wet methods or tool mounted dust collectors where possible.
3. Water mist work surfaces to control dust while cutting.
4. Seal unused doors with duct tape.
5. Block off and seal air vents.
6. Remove or isolate HVAC system in areas where work is being performed.

b. Upon Completion:

1. Wipe work surfaces with cleaner/disinfectant.
2. Contain construction waste before transport in tightly covered containers.
3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.
4. Upon completion, restore HVAC system where work was performed

5. Notify the COR.

3. Class III requirements:

a. During Construction Work:

1. Obtain permit from the COR.
2. Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system.
3. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
4. Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.
5. Contain construction waste before transport in tightly covered containers.
6. Cover transport receptacles or carts. Tape covering unless solid lid.

b. Upon Completion:

1. Do not remove barriers from work area until completed project is inspected by the COR and thoroughly cleaned by the VA Environmental Services Department.
2. Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris

associated with construction, outside of normal work hours.

3. Vacuum work area with HEPA filtered vacuums.
4. Wet mop area with cleaner/disinfectant.
5. Upon completion, restore HVAC system where work was performed.
6. Return permit to the COR.

4. Class IV requirements:

a. During Construction Work:

1. Obtain permit from the COR.
2. Isolate HVAC system in area where work is being done to prevent contamination of duct system.
3. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non-work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins. Install construction barriers and ceiling protection carefully, outside of normal work hours.
4. Maintain negative air pressure, 0.01 inches of water gauge, within work site utilizing HEPA equipped air filtration units and continuously monitored with a digital display, recording and alarm instrument, which must be calibrated on installation, maintained with periodic calibration and monitored by the contractor.5) Seal holes, pipes, conduits, and punctures.
5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they

can wear cloth or paper coveralls that are removed each time they leave work site.

6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.

b. Upon Completion:

1. Do not remove barriers from work area until completed project is inspected by the COR with thorough cleaning by the VA Environmental Services Dept.
2. Remove construction barriers and ceiling protection carefully to minimize spreading of dirt and debris associated with construction, outside of normal work hours.
3. Contain construction waste before transport in tightly covered containers.
4. Cover transport receptacles or carts. Tape covering unless solid lid.
5. Vacuum work area with HEPA filtered vacuums.
6. Wet mop area with cleaner/disinfectant.
7. Upon completion, restore HVAC system where work was performed.
8. Return permit to the COR.

C. Barriers shall be erected as required based upon classification (Class III & IV requires barriers) and shall be constructed as follows:

1. Class III and IV - closed door with masking tape applied over the frame and door is acceptable for projects that can be contained in a single room.
2. Construction, demolition or reconstruction not capable of containment within a single room must have the following barriers erected and made presentable on hospital occupied side:

- a. Class III & IV (where dust control is the only hazard, and an agreement is reached with the Resident Engineer and Medical Center) - Airtight plastic barrier that extends from the floor to ceiling. Seams must be sealed with duct tape to prevent dust and debris from escaping
- b. Class III & IV - Drywall barrier erected with joints covered or sealed to prevent dust and debris from escaping.
- c. Class III & IV - Seal all penetrations in existing barrier airtight
- d. Class III & IV - Barriers at penetration of ceiling envelopes, chases and ceiling spaces to stop movement air and debris
- e. Class IV only - Anteroom or double entrance openings that allow workers to remove protective clothing or vacuum off existing clothing
- f. Class III & IV - At elevators shafts or stairways within the field of construction, overlapping flap minimum of two feet wide of polyethylene enclosures for personnel access.

D. Products and Materials:

- 1. Sheet Plastic: Fire retardant polystyrene, 6-mil thickness meeting local fire codes
- 2. Barrier Doors: Self Closing, fire-rated as appropriate, solid core doors in steel frame, painted
- 3. Dust proof one-hour fire-rated drywall
- 4. High Efficiency Particulate Air-Equipped filtration machine rated at 95% capture of 0.3 microns including pollen, mold spores and dust particles. HEPA filters should have ASHRAE 85 or other prefilter to extend the useful life of the HEPA. Provide both primary and secondary filtrations units. Maintenance of equipment and replacement of the HEPA filters and other filters will be in accordance with manufacturer's instructions.

5. Exhaust Hoses: Heavy duty, flexible steel reinforced; Ventilation Blower Hose
 6. Adhesive Walk-off Mats: Provide minimum size mats of 24 inches x 36 inches
 7. Disinfectant: Hospital-approved disinfectant or equivalent product
 8. Portable Ceiling Access Module
- E. Before any construction on site begins, all contractor personnel involved in the construction or renovation activity shall be educated and trained in infection prevention measures established by the medical center.
- F. A dust control program will be established and maintained as part of the contractor's infection preventive measures in accordance with the FGI Guidelines for Design and Construction of Healthcare Facilities. Prior to start of work, prepare a plan detailing project-specific dust protection measures with associated product data, including periodic status reports, and submit to COR for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- G. Medical center Infection Control personnel will monitor for airborne disease (e.g. aspergillosis) during construction. A baseline of conditions will 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 with safe thresholds established.
- H. In general, the following preventive measures shall be adopted during construction to keep down dust and prevent mold.
1. Contractor shall verify that construction exhaust to exterior is not reintroduced to the medical center through intake vents or building openings. HEPA filtration is required where the exhaust dust may reenter the medical center.

2. Exhaust hoses shall be exhausted so that dust is not reintroduced to the medical center.
3. Adhesive Walk-off/Carpet Walk-off Mats 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.
4. 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 it is created. Transport these outside the construction area in containers with tightly fitting lids.
5. The contractor shall not haul debris through patient-care areas without prior approval of the Resident Engineer and the Medical Center. When, approved, debris shall be hauled in enclosed dust proof containers or wrapped in plastic and sealed with duct tape. No sharp objects should be allowed to cut through the plastic. Wipe down the exterior of the containers with a damp rag to remove dust. All equipment, tools, material, etc. transported through occupied areas shall be made free from dust and moisture by vacuuming and wipe down.
6. 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.
7. 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.

I. 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.

J. Exterior Construction

1. Contractor shall verify that dust will not be introduced into the medical center through intake vents or building openings. HEPA filtration on intake vents is required where dust may be introduced.
2. Dust created from disturbance of soil such as from vehicle movement will be wetted with use of a water truck as necessary
3. All cutting, drilling, grinding, sanding, or disturbance of materials shall be accomplished with tools equipped with either local exhaust ventilation (i.e. vacuum systems) or wet suppression controls.

1.13 TUBERCULOSIS SCREENING

- A. Contractor shall provide written certification that all contract employees assigned to the work site have had a pre-placement tuberculin screening within 90 days prior to assignment to the worksite and been found have negative TB screening reactions. Contractors shall be required to show documentation of negative TB screening reactions for any additional workers who are added after the 90-day requirement before they will be allowed to work on the work site. NOTE: This can be the Center for Disease Control (CDC) and Prevention and two-step skin testing or a Food and Drug Administration (FDA)-approved blood test.
 1. Contract employees manifesting positive screening reactions to the tuberculin shall be examined according to current CDC guidelines prior to working on VHA property.

2. Subsequently, if the employee is found without evidence of active (infectious) pulmonary TB, a statement documenting examination by a physician shall be on file with the employer (construction contractor), noting that the employee with a positive tuberculin screening test is without evidence of active (infectious) pulmonary TB.
3. If the employee is found with evidence of active (infectious) pulmonary TB, the employee shall require treatment with a subsequent statement to the fact on file with the employer before being allowed to return to work on VHA property.

1.14 FIRE SAFETY

- A. Fire Safety Plan: Establish and maintain a site-specific 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 for review for compliance with contract requirements in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. This plan may be an element of the Accident Prevention Plan.
- B. 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.
- C. 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).
- D. Temporary Construction Partitions:
 1. Install and maintain temporary construction partitions to provide smoke-tight separations between construction areas and adjoining areas. Construct partitions of gypsum board or treated plywood

(flame spread rating of 25 or less in accordance with ASTM E84) on both sides of fire-retardant treated wood or metal steel studs. Extend the partitions to floor slab deck or roof. Seal joints and penetrations. At door openings, install Class C, $\frac{3}{4}$ hour fire/smoke rated doors with self-closing devices.

2. Install one-hour fire-rated temporary construction partitions to maintain integrity of existing exit stair enclosures, exit passageways, fire-rated enclosures of hazardous areas, horizontal exits, smoke barriers, vertical shafts and openings enclosures.
 3. Close openings in smoke barriers and fire-rated construction to maintain fire ratings. Seal penetrations with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.
- E. Temporary Heating and Electrical: Install, use and maintain installations in accordance with 29 CFR 1926, NFPA 241 and NFPA 70.
- F. Means of Egress: Do not block exiting for occupied buildings, including paths from exits to roads. Minimize disruptions and coordinate with COR.
- G. Egress Routes for Construction Workers: Maintain free and unobstructed egress. Inspect daily. Report findings and corrective actions weekly to COR.
- H. Fire Extinguishers: Provide and maintain extinguishers in construction areas and temporary storage areas in accordance with 29 CFR 1926, NFPA 241 and NFPA 10.
- I. Flammable and Combustible Liquids: Store, dispense and use liquids in accordance with 29 CFR 1926, NFPA 241 and NFPA 30.
- J. 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. 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 Resident Engineer.

- K. Smoke Detectors: Prevent accidental operation. Remove temporary covers at end of work operations each day. Coordinate with COR.
- L. Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate with COR. Obtain permits if required from COR at least 48 hours in advance. Designate contractor's responsible project-site fire prevention program manager to permit hot work.
- M. Fire Hazard Prevention and Safety Inspections: Inspect entire construction areas weekly. Coordinate with, and report findings and corrective actions weekly to COR.
- N. Smoking: Smoking is prohibited in and adjacent to construction areas inside existing buildings and additions under construction. In separate and detached buildings under construction, smoking is prohibited except in designated smoking rest areas.
- O. Dispose of waste and debris in accordance with NFPA 241. Remove from buildings daily.
- P. 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.

1.15 ELECTRICAL

- A. All electrical work shall comply with NFPA 70 (NEC), NFPA 70B, NFPA 70E, 29 CFR Part 1910 Subpart J - General Environmental Controls, 29 CFR Part 1910 Subpart S - Electrical, and 29 CFR 1926 Subpart K in addition to other references required by contract.
- B. All qualified persons performing electrical work under this contract shall be licensed journeyman or master electricians. All apprentice electricians performing under this contract shall be deemed unqualified

persons unless they are working under the immediate supervision of a licensed electrician or master electrician.

C. All electrical work will be accomplished de-energized and in the Electrically Safe Work Condition (refer to NFPA 70E for Work Involving Electrical Hazards, including Exemptions to Work Permit). Any Contractor, subcontractor or temporary worker who fails to fully comply with this requirement is subject to immediate termination in accordance with FAR clause 52.236-5(c). Only in rare circumstance where achieving an electrically safe work condition prior to beginning work would increase or cause additional hazards or is infeasible due to equipment design or operational limitations is energized work permitted. The COR with approval of the Medical Center Director will make the determination if the circumstances would meet the exception outlined above. An AHA and permit specific to energized work activities will be developed, reviewed, and accepted by the VA prior to the start of that activity.

1. Development of a Hazardous Electrical Energy Control Procedure is required prior to de-energization. A single Simple Lockout/Tagout Procedure for multiple work operations can only be used for work involving qualified person(s) de-energizing one set of conductors or circuit part source. Task specific Complex Lockout/Tagout Procedures are required at all other times.
2. Verification of the absence of voltage after de-energization and lockout/tagout is considered "energized electrical work" (live work) under NFPA 70E, and shall only be performed by qualified persons wearing appropriate shock protective (voltage rated) gloves and arc rate personal protective clothing and equipment, using Underwriters Laboratories (UL) tested and appropriately rated contact electrical testing instruments or equipment appropriate for the environment in which they will be used.
3. Personal Protective Equipment (PPE) and electrical testing instruments will be readily available for inspection by the COR or his designated representative.

- D. Before beginning any electrical work, an Activity Hazard Analysis (AHA) will be conducted to include Shock Hazard and Arc Flash Hazard analyses (NFPA Tables can be used only as a last alternative and it is strongly suggested a full Arc Flash Hazard Analyses be conducted). Work shall not begin until the AHA for the work activity and permit for energized work has been reviewed and accepted by the COR and discussed with all engaged in the activity, including the Contractor, subcontractor(s), and Government on-site representatives at preparatory and initial control phase meetings.
- E. Ground-fault circuit interrupters. GFCI protection shall be provided where an employee is operating or using cord- and plug-connected tools related to construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than 125-volt, 15-, 20-, or 30- ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented in accordance with NFPA 70E - 2015, Chapter 1, Article 110.4(C) (2)..

1.16 FALL PROTECTION

- A. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) for ALL WORK, unless specified differently or the OSHA 29 CFR 1926 requirements are more stringent, to include steel erection activities, systems-engineered activities (prefabricated) metal buildings, residential (wood) construction and scaffolding work.
1. The use of a Safety Monitoring System (SMS) as a fall protection method is prohibited.
 2. The use of Controlled Access Zone (CAZ) as a fall protection method is prohibited.
 3. A Warning Line System (WLS) may ONLY be used on floors or flat or low-sloped roofs (between 0 - 18.4 degrees or 4:12 slope) and shall be erected around all sides of the work area (See 29 CFR 1926.502(f) for construction of WLS requirements). Working within the WLS does not require FP. No worker shall be allowed in the area between the roof or floor edge and the WLS without FP. FP is required when working outside the WLS.

4. Fall protection while using a ladder will be governed by the OSHA requirements.

1.17 SCAFFOLDS AND OTHER WORK PLATFORMS

- A. All scaffolds and other work platforms construction activities shall comply with 29 CFR 1926 Subpart L.
- B. The fall protection (FP) threshold height requirement is 6 ft (1.8 m) as stated in Section 1.16.
- C. The following hierarchy and prohibitions shall be followed in selecting appropriate work platforms.
 1. Scaffolds, platforms, or temporary floors shall be provided for all work except that can be performed safely from the ground or similar footing.
 2. Ladders less than 20 feet may be used as work platforms only when use of small hand tools or handling of light material is involved.
 3. Ladder jacks, lean-to, and prop-scaffolds are prohibited.
 4. Emergency descent devices shall not be used as working platforms.
- D. Contractors shall use a scaffold tagging system in which all scaffolds are tagged by the Competent Person. Tags shall be color-coded: green indicates the scaffold has been inspected and is safe to use; red indicates the scaffold is unsafe to use. Tags shall be readily visible, made of materials that will withstand the environment in which they are used, be legible and shall include:
 1. The Competent Person's name and signature.
 2. Dates of initial and last inspections.
- E. Mast Climbing work platforms: When access ladders, including masts designed as ladders, exceed 20 ft (6 m) in height, positive fall protection shall be used.

1.18 EXCAVATION AND TRENCHES

- A. All excavation and trenching work shall comply with 29 CFR 1926 Subpart P. Excavations less than 5 feet in depth require evaluation by the contractor's "Competent Person" (CP) for determination of the necessity of an excavation protective system where kneeling, laying in, or stooping within the excavation is required.
- B. All excavations and trenches 24 inches in depth or greater shall require a written trenching and excavation permit (NOTE - some States and other local jurisdictions require separate state/jurisdiction-issued excavation permits). The permit shall have two sections, one section will be completed prior to digging or drilling and the other will be completed prior to personnel entering the excavations greater than 5 feet in depth. Each section of the permit shall be provided to the COR prior to proceeding with digging or drilling and prior to proceeding with entering the excavation. After completion of the work and prior to opening a new section of an excavation, the permit shall be closed out and provided to the COR. The permit shall be maintained onsite and the first section of the permit shall include the following:
1. Estimated start time & stop time
 2. Specific location and nature of the work.
 3. Indication of the contractor's "Competent Person" (CP) in excavation safety with qualifications and signature. Formal course in excavation safety is required by the contractor's CP.
 4. Indication of whether soil or concrete removal to an offsite location is necessary.
 5. Indication of whether soil samples are required to determine soil contamination.
 6. Indication of coordination with local authority (i.e. "One Call") or contractor's effort to determine utility location with search and survey equipment.
 7. Indication of review of site drawings for proximity of utilities to digging/drilling.

The second section of the permit for excavations greater than five feet in depth shall include the following:

1. Determination of OSHA classification of soil. Soil samples will be from freshly dug soil with samples taken from different soil type layers as necessary and placed at a safe distance from the excavation by the excavating equipment. A pocket penetrometer will be utilized in determination of the unconfined compression strength of the soil for comparison against OSHA table (Less than 0.5 Tons/FT² - Type C, 0.5 Tons/FT² to 1.5 Tons/FT² - Type B, greater than 1.5 Tons/FT² - Type A without condition to reduce to Type B).
 2. Indication of selected protective system (sloping/benching, shoring, shielding). When soil classification is identified as "Type A" or "Solid Rock", only shoring or shielding or Professional Engineer designed systems can be used for protection. A Sloping/Benching system may only be used when classifying the soil as Type B or Type C. Refer to Appendix B of 29 CFR 1926, Subpart P for further information on protective systems designs.
 3. Indication of the spoil pile being stored at least 2 feet from the edge of the excavation and safe access being provided within 25 feet of the workers.
 4. Indication of assessment for a potential toxic, explosive, or oxygen deficient atmosphere where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist. Internal combustion engine equipment is not allowed in an excavation without providing force air ventilation to lower the concentration to below OSHA PELs, providing sufficient oxygen levels, and atmospheric testing as necessary to ensure safe levels are maintained.
- C. As required by OSHA 29 CFR 1926.651(b)(1), the estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be

expected to be encountered during excavation work, shall be determined prior to opening an excavation.

1. The planned dig site will be outlined/marked in white prior to locating the utilities.
 2. Used of the American Public Works Association Uniform Color Code is required for the marking of the proposed excavation and located utilities.
 3. 811 will be called two business days before digging on all local or State lands and public Right-of Ways.
 4. Digging will not commence until all known utilities are marked.
 5. Utility markings will be maintained
- D. Excavations will be hand dug or excavated by other similar safe and acceptable means as excavation operations approach within 3 to 5 feet of identified underground utilities. Exploratory bar or other detection equipment will be utilized as necessary to further identify the location of underground utilities.
- E. Excavations greater than 20 feet in depth require a Professional Engineer designed excavation protective system.

1.19 CRANES

- A. All crane work shall comply with 29 CFR 1926 Subpart CC.
- B. Prior to operating a crane, the operator must be licensed, qualified or certified to operate the crane. Thus, all the provisions contained with Subpart CC are effective and there is no "Phase In" date.
- C. A detailed lift plan for all lifts shall be submitted to the COR 14 days prior to the scheduled lift complete with route for truck carrying load, crane load analysis, siting of crane and path of swing and all other elements of a critical lift plan where the lift meets the definition of a critical lift. Critical lifts require a more comprehensive lift plan to minimize the potential of crane failure and/or catastrophic loss. The plan must be reviewed and accepted by the General Contractor before being submitted to the VA for review. The

lift will not be allowed to proceed without prior acceptance of this document.

D. Crane operators shall not carry loads

1. over the general public or VAMC personnel
2. over any occupied building unless
 - a. the top two floors are vacated
 - b. or overhead protection with a design live load of 300 psf is provided

1.20 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

- A. All installation, maintenance, and servicing of equipment or machinery shall comply with 29 CFR 1910.147 except for specifically referenced operations in 29 CFR 1926 such as concrete & masonry equipment [1926.702(j)], heavy machinery & equipment [1926.600(a)(3)(i)], and process safety management of highly hazardous chemicals (1926.64). Control of hazardous electrical energy during the installation, maintenance, or servicing of electrical equipment shall comply with Section 1.15 to include NFPA 70E and other VA specific requirements discussed in the section.

1.21 CONFINED SPACE ENTRY

- A. All confined space entry shall comply with 29 CFR 1926, Subpart AA except for specifically referenced operations in 29 CFR 1926 such as excavations/trenches [1926.651(g)].
- B. A site-specific Confined Space Entry Plan (including permitting process) shall be developed and submitted to theCOR.

1.22 WELDING AND CUTTING

As specified in section 1.14, Hot Work: Perform and safeguard hot work operations in accordance with NFPA 241 and NFPA 51B. Coordinate withCOR. Obtain permits or permission from COR at least 48 hours in advance.

1.23 LADDERS

- A. All Ladder use shall comply with 29 CFR 1926 Subpart X.

- B. All portable ladders shall be of sufficient length and shall be placed so that workers will not stretch or assume a hazardous position.
- C. Manufacturer safety labels shall be in place on ladders
- D. Step Ladders shall not be used in the closed position
- E. Top steps or cap of step ladders shall not be used as a step
- F. Portable ladders, used as temporary access, shall extend at least 3 ft (0.9 m) above the upper landing surface.
 - 1. When a 3 ft (0.9-m) extension is not possible, a grasping device (such as a grab rail) shall be provided to assist workers in mounting and dismounting the ladder.
 - 2. In no case shall the length of the ladder be such that ladder deflection under a load would, by itself, cause the ladder to slip from its support.
- G. Ladders shall be inspected for visible defects on a daily basis and after any occurrence that could affect their safe use. Broken or damaged ladders shall be immediately tagged "DO NOT USE," or with similar wording, and withdrawn from service until restored to a condition meeting their original design.

1.24 FLOOR & WALL OPENINGS

- A. All floor and wall openings shall comply with 29 CFR 1926 Subpart M.
- B. Floor and roof holes/openings are any that measure over 2 in (51 mm) in any direction of a walking/working surface which persons may trip or fall into or where objects may fall to the level below. Skylights located in floors or roofs are considered floor or roof hole/openings.
- C. All floor, roof openings or hole into which a person can accidentally walk or fall through shall be guarded either by a railing system with toe boards along all exposed sides or a load-bearing cover. When the cover is not in place, the opening or hole shall be protected by a removable guardrail system or shall be attended when the guarding system has been removed, or other fall protection system.

1. Covers shall be capable of supporting, without failure, at least twice the weight of the worker, equipment and material combined.
2. Covers shall be secured when installed, clearly marked with the word "HOLE", "COVER" or "Danger, Roof Opening-Do Not Remove" or color-coded or equivalent methods (e.g., red or orange "X"). Workers must be made aware of the meaning for color coding and equivalent methods.
3. Roofing material, such as roofing membrane, insulation, or felts, covering or partly covering openings or holes, shall be immediately cut out. No hole or opening shall be left unattended unless covered.
4. Non-load-bearing skylights shall be guarded by a load-bearing skylight screen, cover, or railing system along all exposed sides.
5. Workers are prohibited from standing/walking on skylights.

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**SECTION 01 42 19
REFERENCE STANDARDS**

PART 1 - GENERAL

1.1 DESCRIPTION

This section lists 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.aabchq.com>

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

AASHTO American Association of State Highway and Transportation
Officials
<http://www.aashto.org>

AATCC American Association of Textile Chemists and Colorists
<http://www.aatcc.org>

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

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

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

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

ADC Air Diffusion Council
<http://flexibleduct.org>

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

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

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

AH American Hort
<https://www.americanhort.org>

AHAM Association of Home Appliance Manufacturers
<http://www.aham.org>

AIA American Institute of Architects
<http://www.aia.org>

AISC American Institute of Steel Construction
<http://www.aisc.org>

AISI American Iron and Steel Institute
<http://www.steel.org>

AITC American Institute of Timber Construction
<https://aitc-glulam.org>

AMCA Air Movement and Control Association, Inc.
<http://www.amca.org>

ANSI American National Standards Institute, Inc.
<http://www.ansi.org>

APA The Engineered Wood Association
<http://www.apawood.org>

ARI Air-Conditioning and Refrigeration Institute
<http://www.ari.org>

ARPM Association for Rubber Product Manufacturers
<https://arpm.com>

ASABE American Society of Agricultural and Biological Engineers
<https://www.asabe.org>

ASCE American Society of Civil Engineers
<http://www.asce.org>

ASHRAE American Society of Heating, Refrigerating, and
Air-Conditioning Engineers
<http://www.ashrae.org>

ASME American Society of Mechanical Engineers
<http://www.asme.org>

ASSE American Society of Sanitary Engineering International
<http://www.asse-plumbing.org>

ASTM American Society for Testing and Materials International
<http://www.astm.org>

AWI Architectural Woodwork Institute
<https://www.awinet.org>

AWS American Welding Society
<https://www.aws.org>

AWWA American Water Works Association
<https://www.awwa.org>

BHMA Builders Hardware Manufacturers Association
<https://www.buildershardware.com>

BIA The Brick Industry Association
<http://www.gobrick.com>

CAGI Compressed Air and Gas Institute
<https://www.cagi.org>

CGA Compressed Gas Association, Inc.
<https://www.cganet.com>

CI The Chlorine Institute, Inc.
<https://www.chlorineinstitute.org>

CISCA Ceilings and Interior Systems Construction Association
<https://www.cisca.org>

CISPI Cast Iron Soil Pipe Institute
<https://www.cispi.org>

CLFMI Chain Link Fence Manufacturers Institute
<https://www.chainlinkinfo.org>

CPA Composite Panel Association
<https://www.compositepanel.org>

CPMB Concrete Plant Manufacturers Bureau
<https://www.cpmc.org>

CRA California Redwood Association
<http://www.calredwood.org>

CRSI Concrete Reinforcing Steel Institute
<https://www.crsi.org>

CTI Cooling Technology Institute
<https://www.cti.org>

DHA Decorative Hardwoods Association
<https://www.decorativehardwood.org>

DHI Door and Hardware Institute
<https://www.dhi.org>

EGSA Electrical Generating Systems Association
<http://www.egsa.org>

EEI Edison Electric Institute
<https://www.eei.org>

EPA United States Environmental Protection Agency
<https://www.epa.gov>

ETL ETL Testing Services
<http://www.intertek.com>

FAA Federal Aviation Administration
<https://www.faa.gov>

FCC Federal Communications Commission
<https://www.fcc.gov>

FPS Forest Products Society
<http://www.forestprod.org>

GANNA Glass Association of North America
<http://www.glasswebsite.com>

FM Factory Mutual Global Insurance
<https://www.fmglobal.com>

GA Gypsum Association
<https://gypsum.org>

GSA General Services Administration
<https://www.gsa.gov>

HI Hydraulic Institute
<http://www.pumps.org>

ICC International Code Council
<https://shop.iccsafe.org>

ICEA Insulated Cable Engineers Association
<https://www.icea.net>

ICAC Institute of Clean Air Companies
<http://www.icac.com>

IEEE Institute of Electrical and Electronics Engineers
<https://www.ieee.org>

IGMA Insulating Glass Manufacturers Alliance
<https://www.igmaonline.org>

IMSA International Municipal Signal Association
<http://www.imsasafety.org>

MBMA Metal Building Manufacturers Association
<https://www.mbma.com>

MSS Manufacturers Standardization Society of the Valve and Fittings Industry
<http://msshq.org>

NAAMM National Association of Architectural Metal Manufacturers
<https://www.naamm.org>

PHCC Plumbing-Heating-Cooling Contractors Association
<https://www.phccweb.org>

NBS National Bureau of Standards
See - NIST

NBBI The National Board of Boiler and Pressure Vessel Inspectors
<https://www.nationalboard.org>

NEC National Electric Code
See - NFPA National Fire Protection Association

NEMA National Electrical Manufacturers Association
<https://www.nema.org>

NFPA National Fire Protection Association
<https://www.nfpa.org>

NHLA National Hardwood Lumber Association
<https://www.nhla.com>

NIH National Institute of Health
<https://www.nih.gov>

NIST National Institute of Standards and Technology
<https://www.nist.gov>

NELMA Northeastern Lumber Manufacturers Association, Inc.
<http://www.nelma.org>

NPA National Particleboard Association
(See CPA, Composite Panel Association)

NSF National Sanitation Foundation
<http://www.nsf.org>

OSHA Occupational Safety and Health Administration
Department of Labor
<https://www.osha.gov>

PCA Portland Cement Association
<https://www.cement.org>

PCI Precast Prestressed Concrete Institute
<https://www.pci.org>

PPI Plastics Pipe Institute
<https://www.plasticpipe.org>

PEI Porcelain Enamel Institute
<http://www.porcelainenamel.com>

PTI Post-Tensioning Institute
<http://www.post-tensioning.org>

RFCI Resilient Floor Covering Institute
<https://www.rfci.com>

RIS Redwood Inspection Service
(See Western Wood Products Association)
<https://www.wwpa.org>

SCMA Southern Cypress Manufacturers Association
<http://www.cypressinfo.org>

SDI Steel Door Institute
<http://www.steeldoor.org>

SJI Steel Joist Institute
<https://www.steeljoist.org>

SMACNA Sheet Metal & Air-Conditioning Contractors'
National Association
<https://www.smacna.org>

SSPC The Society for Protective Coatings
<https://www.sspc.org>

STI Steel Tank Institute
<https://www.steeltank.com>

SWI Steel Window Institute
<https://www.steelwindows.com>

TCNA Tile Council of North America
<https://www.tcnatile.com>

TEMA Tubular Exchanger Manufacturers Association
<http://www.tema.org>

TPI Truss Plate Institute
<https://www.tpinst.org>

UBC The Uniform Building Code
(See ICC)

UL Underwriters' Laboratories Incorporated
<https://www.ul.com>

ULC Underwriters' Laboratories of Canada
<https://www.ulc.ca>

WCLB West Coast Lumber Inspection Bureau
<http://www.wclib.org>

WDMA Window and Door Manufacturers Association
<https://www.wdma.com>

WRCLA Western Red Cedar Lumber Association
<https://www.realcedar.com>

WWPA Western Wood Products Association
<http://www.wwpa.org>

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SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies requirements for Contractor Quality Control (CQC) for Design-Bid-Build (DBB) or Design-Build (DB) construction projects. This section can be used for both project types.

1.2 APPLICABLE PUBLICATIONS

- A. The publication listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. ASTM International (ASTM)
 - 1. D3740 - (2012a) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
 - 2. E329 - (2014a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

1.3 SUBMITTALS

Government approval is required for all submittals. CQC inspection reports shall be submitted under this Specification section and follow the [Applicable CQC Control Phase (Preparatory, Initial, or Follow-Up)]: [Applicable Specification section] naming convention.

- 1. Preconstruction Submittals
 - a. Interim CQC Plan
 - b. CQC Plan
 - c. Additional Requirements for Design Quality Control (DQC) Plan
- 2. Design Data
 - a. Discipline-Specific Checklists
 - b. Design Quality Control
- 3. Test Reports
 - a. Verification Statement

PART 2 PRODUCTS - NOT USED**PART 3 - EXECUTION****3.1 GENERAL REQUIREMENTS**

Establish and maintain an effective quality control (QC) system that complies with the FAR Clause 52.246.12 titled "Inspection of Construction". QC consists of plans, procedures, and organization necessary to produce an end product which complies with the Contract requirements. The QC system covers all design and construction operations, both onsite and offsite, and be keyed to the proposed design and construction sequence. The project superintendent will be held responsible for the quality of work and is subject to removal by the Contracting Office or Authorized designee for non-compliance with the quality requirements specified in the Contract. In this context the highest-level manager responsible for the overall construction activities at the site, including quality and production is the project superintendent. The project superintendent maintains a physical presence at the site at all times and is responsible for all construction and related activities at the site, except as otherwise acceptable to the Contracting Officer.

3.2 CQC PLAN:

- A. Submit no later than 30 days after receipt of Notice to Proceed (NTP) the CQC Plan proposed to implement the requirements of the FAR Clause 52.246.12 titled "Inspection of Construction". The Government will consider an Interim CQC Plan for the first to match timeline established immediately above days of operation, which must be accepted within 5 business days of NTP. Design and/or construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an Interim plan applicable to the particular feature of work to be started. Work outside of the accepted Interim CQC Plan will not be permitted to begin until acceptance of a CQC Plan or another Interim CQC Plan containing the additional work scope is accepted.
- B. Content of the CQC Plan: Include, as a minimum, the following to cover all design and construction operations, both onsite and offsite, including work by subcontractors, designers of record consultants,

architects/engineers (A/E), fabricators, suppliers, and purchasing agents:

1. A description of the QC organization, including a chart showing lines of authority and acknowledgement that the CQC staff will implement the three-phase control system for all aspects of the work specified. Include a CQC System Manager that reports to the project superintendent.
2. The name, qualifications (in resume format) duties, responsibilities, and authorities of each person assigned a CQC function.
3. A copy of the letter to the CQC System Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the Contract. Letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities will to the Contracting Officer or Authorized designee. be issued by the CQC System Manager. Furnish copies of these letters
4. Procedures for scheduling, reviewing, certifying, and managing submittals including those of subcontractors, designers of record, consultants, A/E's offsite fabricators, suppliers and purchasing agents. These procedures must be in accordance with Section 01 33 23 Shop Drawings, Product Data, and Samples.
5. Control, verification, and acceptance of testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities approved by the Contracting Officer or Authorized designee are required to be used)
6. Procedures for tracking Preparatory, Initial, and Follow-Up control phases and control, verification, and acceptance tests including documentation.
7. Procedures for tracking design and construction deficiencies from identification through acceptable corrective action. Establish

verification procedures that identified deficiencies have been corrected.

8. Reporting procedures, including proposed reporting formats.
 9. A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks has separate control requirements, and is identified by different trades or disciplines, or it is work by the same trade in a different environment. Although each section of specifications can generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon during the Coordination meeting.
 10. Coordinate schedule work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections and Schedule of Special Inspections. Where the applicable Code issue by the International Code Council (ICC) calls for inspections by the Building Official, the Contractor must include the inspections in the CQC Plan and must perform the inspections required by the applicable ICC. The Contractor must perform these inspections using independent qualified inspectors. Include the Special Inspection Plan requirements in the CQC Plan.
- C. Acceptance of Plan: Acceptance of the Contractor's plan is required prior to the start of design and construction. Acceptance is conditional and will be predicated on satisfactory performance during the design and construction. The Government reserves the right to require the Contractor to make changes in the CQC Plan and operations including removal of personnel as necessary, to obtain the quality specified.
- D. Notification of Changes: After acceptance of the CQC Plan, notify the Contracting Officer or Authorized designee in writing of any proposed change. Proposed changes are subject to acceptance by the Government prior to implementation by the Contractor.

1.3 COORDINATION MEETING:

After the Preconstruction Conference Post-Award Conference before start of design or construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer or Authorized designee to discuss the Contractor's quality control system. Submit the CQC Plan

a minimum of 2 business days prior to the Coordination Meeting. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CC operations, design activities (if applicable), control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting will be prepared by the Government, signed by both the Contractor and Contracting Officer or Authorized designee and will become a part of the contract file. There can be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

1.4 QUALITY CONTROL ORGANIZATION:

- A. Personnel Requirements: The requirements for the CQC organization are a Safety and Health Manager, CQC System Manager, a Design Quality Manager (if applicable), and sufficient number of additional qualified personnel to ensure safety and Contract compliance. The Safety and Health Manager shall satisfy the requirements of Specification 01 35 26 Safety Requirements and reports directly to a senior project (or corporate) official independent from the CQC System Manager. The Safety and Health Manager will also serve as a member of the CQC Staff. Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly will also be included as part of the CQC organization. The Contractor's CQC staff maintains a presence at the site at all times during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer or Authorized designee. Provide adequate office space, filing systems, and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawings submittals, schedules and all other project documentation to the CQC organization. The CQC organization is responsible to maintain these documents and

records at the site at all times, except as otherwise acceptable to the Government.

- B. CQC System Manager: Identify as CQC System Manager an individual within the onsite work organization that is responsible for overall management of CQC and has the authority to act in all CQC matters for the Contractor. The CQC system Manager is required to be a construction person with a minimum of 5 years in related work. This CQC System manager is on the site at all times during construction and is employed by the General Contractor. The CQC System Manger is assigned as CQC System Manager but has duties as project superintendent in addition to quality control. Identify in the plan an alternate to serve in the event of the CQC System Manager's absence. The requirements for the alternate are the same as the CQC System Manager.
- C. CQC Personnel: In addition to CQC personnel specified elsewhere in the contract, provide as part of the CQC organization specialized personnel to assist in the CQC System Manager for the following areas, as applicable: electrical, mechanical, civil, structural, environmental, architectural, materials technician submittals clerk, Commissioning Agent/LEED specialist, and low voltage systems. These individuals or specified technical companies are directly employed by the General Contractor and cannot be employed by a supplier or subcontractor on this project; be responsible to the CQC System Manager; be physically present at the construction site during work on the specialized personnel's areas of responsibility; have the necessary education or experience in accordance with the Experience Matrix listed herein. These individuals can perform other duties but need to be allowed sufficient time to perform the specialized personnel's assigned quality controls duties as described in the CQC Plan. A single person can cover more than one area provided that the single person is qualified to perform QC activities in each designated and that workload allows.

EXPERIENCE MATRIX

Area	Qualifications
Civil	Graduate Civil Engineer or Construction Manager with 2 years of experience in the type of work being performed on this project or technician with 5 years related experience.
Mechanical	Graduate Mechanical Engineer with 2 years of experience or construction professional with 5 years of experience supervising mechanical features of work in the field with a construction company.
Electrical	Graduate Electrical Engineer with 2 years related experience or construction professional with 5 years of experience supervising electrical features of work in the field with a construction company.
Structural	Graduate Civil Engineer (with Structural Track or Focus), Structural Engineer, or Construction Manager with 2 years of experience or construction professional with 5 years of experience supervising structural features of work in the field with a construction company.
Architectural	Graduate Architect with 2 years of experience or construction professional with 5 years of related experience.
Environmental	Graduate Environmental Engineer with 3 years of experience.
Submittals	Submittal Clerk with 1 year of experience.
Concrete, Pavement, and Soils	Materials Technician with 2 years of experience for the appropriate area.
Testing, Adjusting, and Balancing (TAB)	Specialist must be a member of AABC or an experienced technician of the firm certified by the NEBB.
Design Quality Control Manager	Registered Architect or Professional Engineer

- D. **Additional Requirements:** In addition to the above experience and education requirements, the CQC System Manager and Alternate CQC System Manager are required to have completed the Construction Quality Management (CQM) for Construction course. If the CQC System Manager does not have a current specification, obtain the CQM for Contractors course identification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Command and the Army Corps of Engineers. Contact the Contracting Officer or Authorized designee for information on the next scheduled class.
- E. **Organizational Changes:** Maintain the CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff, revise the CQC Plan to reflect the changes and submit the changes to the Contracting Officer or Authorized designee for acceptance.

1.5 SUBMITTALS AND DELIVERABLES:

Submittals have to comply with the requirements in Section 01 33 23 Shop Drawings, Product Data, and Samples. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the contract requirements. When Section 01 91 00 General Commissioning Requirements is included in the contract, the submittals required by the section have to be coordinated with the Section 01 33 23 Shop Drawings, Product Data, and Samples to ensure adequate time is allowed for each type of submittal required.

1.6 CONTROL:

- A. CQC is the means by which the Contractor ensures that the construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. At least three phases of control are required to be conducted by the CQC System Manager for each definable feature of the construction work as follows:
 - 1. **Preparatory Phase:** This phase is performed prior to beginning work on each definable feature of work after all required plans/documents/materials are approved/accepted, and after copies are at the work site. This phase includes:
 - a. A review of each paragraph of applicable specifications, references codes, and standards. Make available during the

preparatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.

- b. Review of the Contract drawings.
- c. Check to assure that all materials and equipment have been tested, submitted, and approved.
- d. Review of provisions that have been made to provide required control inspection and testing.
- e. Review Special Inspections required by Section 01 45 35 Special Inspections, that Statement of Special Inspections and the Schedule of Specials Inspections.
- f. Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Contract.
- g. Examination of required materials, equipment, and sample work to assure that they are on hand conform to approved shop drawings or submitted data, and are properly stored.
- h. Review of the appropriate Activity Hazard Analysis (AHA) to assure safety requirements are met.
- i. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards - contract defined or industry standard if not contract defined - for that feature of work.
- j. Check to ensure that the portion of the plan for the work to be performed has been accepted by the Contracting Officer.
- k. Discussion of the initial control phase.
- l. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the Preparatory control phase. Include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. Document the results of the Preparatory phase actions by separate minutes prepared by the CQC System Manager and

attach to the daily CQC report. Instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

- B. Initial Phase: This phase is accomplished at the beginning of a definable feature of work. Accomplish the following:
1. Check work to ensure that it is in full compliance with contract requirements. Review minutes of the Preparatory meeting.
 2. Verify adequacy of controls to ensure full contract compliance. Verify the required control inspection and testing is in compliance with the contract.
 3. Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Compare with required sample panels as appropriate.
 4. Resolve all differences.
 5. Check safety to include compliance with an upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 6. The Government needs to be notified at least 48 hours or 2 business days in advance of beginning the initial phase for definable features of work. Prepare separate minutes of this phase by the CQC System Manager and attach to the daily CQC report. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with Follow-Up phases.
 7. The initial phase for each definable feature of work is repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
 8. Coordinate scheduled work with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections.
- C. Follow-Up Phase: Perform daily checks to assure control activities, including control testing, are providing continued compliance with contract requirements until the completion of the particular feature of work. Record the checks in the CQC documentation. Conduct final Follow-Up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work. Do not build upon nor conceal non-conforming work. Coordinate scheduled work

with Special Inspections required by Section 01 45 35 Special Inspections, the Statement of Special Inspections, and the Schedule of Special Inspections

- D. Additional Preparatory and Initial Phases on the same definable features of work if: the quality ongoing work is unacceptable; if there are changes in the applicable CQC staff, onsite production supervision or work crew; if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

1.7 TESTS

- A. Testing Procedure: Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and acceptance test when specified. Procure the services of a Department of Veteran Affairs approved testing laboratory or establish an approved testing laboratory at the project site. Perform the following activities and record and provide the following data:
1. Verify that testing procedures comply with contract requirements.
 2. Verify that facilities and testing equipment are available and comply with testing standards.
 3. Check test instrument calibration data against certified standards.
 4. Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 5. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the unique sequential control number identifying the test. If approved by the Contracting Officer or Authorized designee, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer or Authorized designee. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

- B. Testing Laboratories: All testing laboratories must be validated through the procedures contained in Specification section 01 45 29 Testing Laboratory Services.
1. Capability Check: The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt and steel is required to meet criteria detailed in ASTM D3740 and ASTM E329.
 2. Capability Recheck: If the selected laboratory fails the capability check, the Contractor will be assessed a charge equal to value of recheck to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.
- C. Onsite Laboratory: The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

1.8 COMPLETION INSPECTION

- A. Punch-Out Inspection: Conduct an inspection of the work by the CQC system Manager near the end of the work, or any increment of the work established by a time stated FAR 52.211-10 - Commencement, Prosecution, and Completion of Work, or by the specifications. Prepare and include in the CQC documentation a punch list of items which do not conform to the approved drawings and specifications. Include within the list of deficiencies the estimated date by which the deficiencies will be corrected. Make a second inspection the CQC System Manager or staff to ascertain that all deficiencies have been corrected. Once this is accomplished, notify the Government that the facility is ready for the Government Pre-Final Inspection.

52.211-10 -- Commencement, Prosecution, and Completion of Work.

As prescribed in [11.404\(b\)](#), insert the following clause in solicitations and contracts when a fixed-price construction contract is contemplated. The clause may be changed to accommodate the issuance of orders under indefinite-delivery contracts for construction.

Commencement, Prosecution, and Completion of Work (Apr 1984)

The Contractor shall be required to:

- (a) commence work under this contract within _____ // *Contracting Officer insert number*// calendar days after the date the Contractor receives the notice to proceed,
- (b) prosecute the work diligently, and
- (c) complete the entire work ready for use not later than _____.* The time stated for completion shall include final cleanup of the premises.

(End of Clause)

* The Contracting Officer shall specify either a number of days after the date the contractor receives the notice to proceed, or a calendar date.

Alternate I (Apr 1984). If the completion date is expressed as a specific calendar date, computed on the basis of the contractor receiving the notice to proceed by a certain day, add the following paragraph to the basic clause:

The completion date is based on the assumption that the successful offeror will receive the notice to proceed by _____ // *Contracting Officer insert date* //. The completion date will be extended by the number of calendar days after the above date that the Contractor receives the notice to proceed, except to the extent that the delay in issuance of the notice to proceed results from the failure of the Contractor to execute the contract and give the required performance and payment bonds within the time specified in the offer.

- B. Pre-Final Inspection: The Government will perform the Pre-Final Inspection to verify that the facility is complete and ready to be occupied. A Government Pre-Final Punch List may be developed as a result of this inspection. Ensure that all items on this list have been corrected before notifying the Government, so that a Final Acceptance Inspection with the customer can be scheduled. Correct any items noted on the Pre-Final Inspection in a timely manner. These inspections and any deficiency corrections required by this paragraph need to be accomplished within the time slated for completion of the entire work or any particular increment of the work if the project is divided into increments by separate construction completion dates.
- C. Final Acceptance Inspection: The Contractor's QC Inspection personnel, plus the superintendent or other primary management person, and the

Contracting Officer's Authorized designee is required to be in attendance at the Final Acceptance Inspection. Additional Government personnel can also be in attendance. The Final Acceptance Inspection will be formally scheduled by the Contracting Officer's or Authorized designee based upon results of the Pre-Final Inspection. Notify the Contracting Officer through the Resident Engineer office at least 14 days prior to the Final Acceptance Inspection and include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date schedule for the Final Acceptance Inspection. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with FAR Clause 52.246-12 titled "Inspection of Construction".

1.9 DOCUMENTATION

- A. Quality Control Activities: Maintain current records providing factual evidence that required QC activities and tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:
1. The name and area of responsibility of the Contractor/Subcontractor
 2. Operating plant/equipment with hours worked, idle, or down for repair.
 3. Work performed each day, giving location, description, and by whom. When Network Analysis (NAS) is used, identify each phase of work performed each day by NAS activity number.
 4. Test and control activities performed with results and references to specification/drawing requirements. Identify the Control Phase (Preparatory, Initial, and/or Follow-Up). List deficiencies noted, along with corrective action.
 5. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specification/drawing requirements.
 6. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.

7. Offsite surveillance activities, including actions taken.
 8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 9. Instructions given/received and conflicts in plans and specifications.
 10. Provide documentation of design quality control activities. For independent design reviews, provide, as a minimum, identification of the Independent Technical Reviewer (ITR) team, the ITR review comments, responses, and the record of resolution of the comments.
- B. Verification Statement: Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract. Furnish the original and one copy of these records in report form to the Government daily with 1 week after the date covered by the report, except that reports need not be submitted for days on which no work is performed. As a minimum, prepare and submit on report for every 7 days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the CQC System Manager. Include copies of test reports and copies of reports prepared by all subordinate QC personnel within the CQC System Manager Report.

1.10 SAMPLE FORMS

Templates of various quality control reports can be found on the Whole Building Design Guide website at

https://www.wbdg.org/FFC/NAVGRAPH/quality_control_reports.pdf

1.11 NOTIFICATION OF NONCOMPLIANCE:

The Contracting Officer or Authorized designee will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor should take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site will be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly,

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the Contracting Officer can issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

--- End of Section ---

**SECTION 01 45 29
TESTING LABORATORY SERVICES**

PART 1 - GENERAL

1.1) DESCRIPTION:

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

1.2) APPLICABLE PUBLICATIONS:

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

B) American Association of State Highway and Transportation Officials (AASHTO):

T27-11Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

T96-02 (R2006)Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

T99-10Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop

T104-99 (R2007)Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

T180-10Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop

T191-02 (R2006)Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method

T310-13Standard Method of Test for In-place Density and Moisture Content of Soil and Soil-aggregate by Nuclear Methods (Shallow Depth)

C) American Concrete Institute (ACI):

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

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

- A370-12Standard Test Methods and Definitions for
Mechanical Testing of Steel Products
- A416/A416M-10Standard Specification for Steel Strand,
Uncoated Seven-Wire for Prestressed Concrete
- C31/C31M-10Standard Practice for Making and Curing
Concrete Test Specimens in the Field
- C33/C33M-11aStandard Specification for Concrete Aggregates
- C39/C39M-12Standard Test Method for Compressive Strength
of Cylindrical Concrete Specimens
- C109/C109M-11bStandard Test Method for Compressive Strength
of Hydraulic Cement Mortars
- C136-06Standard Test Method for Sieve Analysis of Fine
and Coarse Aggregates
- C138/C138M-10bStandard Test Method for Density (Unit Weight),
Yield, and Air Content (Gravimetric) of
Concrete
- C140-12Standard Test Methods for Sampling and Testing
Concrete Masonry Units and Related Units
- C143/C143M-10aStandard Test Method for Slump of Hydraulic
Cement Concrete
- C172/C172M-10Standard Practice for Sampling Freshly Mixed
Concrete
- C173/C173M-10bStandard Test Method for Air Content of freshly
Mixed Concrete by the Volumetric Method
- C330/C330M-09Standard Specification for Lightweight
Aggregates for Structural Concrete
- C567/C567M-11Standard Test Method for Density Structural
Lightweight Concrete
- C780-11Standard Test Method for Pre-construction and
Construction Evaluation of Mortars for Plain
and Reinforced Unit Masonry
- C1019-11Standard Test Method for Sampling and Testing
Grout
- C1064/C1064M-11Standard Test Method for Temperature of Freshly
Mixed Portland Cement Concrete

C1077-11cStandard Practice for Agencies Testing Concrete
and Concrete Aggregates for Use in Construction
and Criteria for Testing Agency Evaluation

C1314-11aStandard Test Method for Compressive Strength
of Masonry Prisms

D422-63(2007)Standard Test Method for Particle-Size Analysis
of Soils

D698-07e1Standard Test Methods for Laboratory Compaction
Characteristics of Soil Using Standard Effort

D1140-00(2006)Standard Test Methods for Amount of Material in
Soils Finer than No. 200 Sieve

D1143/D1143M-07e1Standard Test Methods for Deep Foundations
Under Static Axial Compressive Load

D1188-07e1Standard Test Method for Bulk Specific Gravity
and Density of Compacted Bituminous Mixtures
Using Coated Samples

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

D1557-09Standard Test Methods for Laboratory Compaction
Characteristics of Soil Using Modified Effort
(56,000ft lbf/ft³ (2,700 KNm/m³))

D2166-06Standard Test Method for Unconfined Compressive
Strength of Cohesive Soil

D2167-08)Standard Test Method for Density and Unit
Weight of Soil in Place by the Rubber Balloon
Method

D2216-10Standard Test Methods for Laboratory
Determination of Water (Moisture) Content of
Soil and Rock by Mass

D2974-07aStandard Test Methods for Moisture, Ash, and
Organic Matter of Peat and Other Organic Soils

D3666-11Standard Specification for Minimum Requirements
for Agencies Testing and Inspecting Road and
Paving Materials

D3740-11Standard Practice for Minimum Requirements for
Agencies Engaged in Testing and/or Inspection

- of Soil and Rock as used in Engineering Design and Construction
- D6938-10Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- E94-04 (2010)Standard Guide for Radiographic Examination
- E164-08Standard Practice for Contact Ultrasonic Testing of Weldments
- E329-11cStandard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
- E543-09Standard Specification for Agencies Performing Non-Destructive Testing
- E605-93 (R2011)Standard Test Methods for Thickness and Density of Sprayed Fire Resistive Material (SFRM) Applied to Structural Members
- E709-08Standard Guide for Magnetic Particle Examination
- E1155-96 (R2008)Determining FF Floor Flatness and FL Floor Levelness Numbers
- F3125/F3125M-15Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
- E) American Welding Society (AWS):
 - D1.D1.1M-10Structural Welding Code-Steel

1.3) REQUIREMENTS:

- A) Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e. E329, C1077, D3666, D3740, A880, E543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific

laboratory performing the actual testing, not just the "Corporate Office."

- B) Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by the Contracting Officer's Representative (COR). When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of COR to such failure.
- C) Written Reports: Testing laboratory shall submit test reports to COR, Contractor, unless other arrangements are agreed to in writing by the COR. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D) Verbal Reports: Give verbal notification to COR immediately of any irregularity.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EARTHWORK:

- A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:
 - 1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the COR regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to COR extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
 - 2. Provide part time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.

3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.

B. Testing Compaction:

1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with ASTM D698 and/or ASTM D1557.
2. Make field density tests in accordance with the primary testing method following ASTM D6938 wherever possible. Field density tests utilizing ASTM D1556, AASHTO T191, or ASTM D2167 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the COR before the tests are conducted.
 - a. Building Slab Subgrade: At least one test of subgrade for every 185 m² (2000 square feet) of building slab, but in no case fewer than one test. In each compacted fill layer, perform one test for every 185 m² (2000 square feet) of overlaying building slab, but in no case fewer than one test.
 - b. Foundation Wall Backfill: One test per 30 m (100 feet) of each layer of compacted fill but in no case fewer than two tests.
 - c. Pavement Subgrade: One test for each 335 m² (400 square yards), but in no case fewer than two tests.
 - d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
 - e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200 mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
 - f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to COR. In each compacted fill layer below wall footings, perform one field density test for every 30 m (100 feet) of wall. Verify subgrade is level, all loose or disturbed

soils have been removed, and correlate actual soil conditions observed with those indicated by test borings.

- C. Fill and Backfill Material Gradation: One test per 10 cubic yards stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C136.
- D. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- E. Testing Materials: Test suitability of on-site and off-site borrow as directed by COR.

3.2 ASPHALT CONCRETE PAVING:

A. Aggregate Base Course:

1. Determine maximum density and optimum moisture content for aggregate base material in accordance with AASHTO T180, Method D.
2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with AASHTO T191.
3. Sample and test aggregate as necessary to ensure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.

B. Asphalt Concrete:

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

3.3 SITE WORK CONCRETE:

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

3.4 CONCRETE:

A. Materials Testing:

1. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

B. Field Inspection and Materials Testing:

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.
2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 40 m³ (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. Label each cylinder with an identification number. COR may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m³ (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m³ (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.

6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
 - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
 - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
 - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.

- b. Inspect preparation of construction, expansion, and isolation joints.
 - 16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
 - 17. Observe concrete mixing:
 - a. Monitor and record amount of water added at project site.
 - b. Observe minimum and maximum mixing times.
 - 18. Measure concrete flatwork for levelness and flatness as follows:
 - a. Perform Floor Tolerance Measurements F_F and F_L in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
 - b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
 - c. Provide the Contractor and the COR with the results of all profile tests, including a running tabulation of the overall F_F and F_L values for all slabs installed to date, within 72 hours after each slab installation.
 - 19. Other inspections:
 - a. Grouting under base plates.
 - b. Grouting anchor bolts and reinforcing steel in hardened concrete.
- C. Laboratory Tests of Field Samples:
- 1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by COR. Compile laboratory test reports as follows: Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.
 - 2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
 - 3. Furnish certified compression test reports (duplicate) to COR. In test report, indicate the following information:
 - a. Cylinder identification number and date cast.
 - b. Specific location at which test samples were taken.
 - c. Type of concrete, slump, and percent air.

- d. Compressive strength of concrete in MPa (psi).
- e. Weight of lightweight structural concrete in kg/m³ (pounds per cubic feet).
- f. Weather conditions during placing.
- g. Temperature of concrete in each test cylinder when test cylinder was molded.
- h. Maximum and minimum ambient temperature during placing.
- i. Ambient temperature when concrete sample in test cylinder was taken.
- j. Date delivered to laboratory and date tested.

3.5 REINFORCEMENT:

- A. Review mill test reports furnished by Contractor.

3.6 STRUCTURAL STEEL:

- A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.
- B. Prefabrication Inspection:
 - 1. Review design and shop detail drawings for size, length, type and location of all welds to be made.
 - 2. Approve welding procedure qualifications either by pre-qualification or by witnessing qualifications tests.
 - 3. Approve welder qualifications by certification or retesting.
 - 4. Approve procedure for control of distortion and shrinkage stresses.
 - 5. Approve procedures for welding in accordance with applicable sections of AWS D1.1.
- C. Fabrication and Erection:
 - 1. Weld Inspection:
 - a. Inspect welding equipment for capacity, maintenance and working condition.
 - b. Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
 - c. Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
 - d. Inspect preheating and interpass temperatures for conformance with AWS D1.1.
 - e. Measure 25 percent of fillet welds.

- f. Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
 - 1) 20 percent of all shear plate fillet welds at random, final pass only.
 - 2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
 - 3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
 - 4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.
 - 5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
 - g. Welding Ultrasonic Testing: Test in accordance with ASTM E164 and AWS D1.1 for 100 percent of all full penetration welds, braced and moment frame column splices, and a minimum of 20 percent of all other partial penetration column splices, at random.
 - h. Welding Radiographic Testing: Test in accordance with ASTM E94, and AWS D1.1 for 5 percent of all full penetration welds at random.
 - i. Verify that corrections of rejected welds are made in accordance with AWS D1.1.
 - j. Testing and inspection do not relieve the Contractor of the responsibility for providing materials and fabrication procedures in compliance with the specified requirements.
2. Bolt Inspection:
- a. Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM F3125 Bolts.
 - b. Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM F3125 Bolts. Inspect all bolts in connection when one or more are rejected.
 - c. Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of

connections in accordance with AISC Specification for Structural Joints Using ASTM F3125 Bolts. Inspect all bolts in connection when one or more are rejected.

- d. Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
 - e. Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
 - f. Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to COR.

3.7 STEEL DECKING:

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

3.8 SHEAR CONNECTOR STUDS:

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

3.9 TYPE OF TEST:

Approximate Number of Tests Required

- A. Earthwork:
Laboratory Compaction Test, Soils:

(ASTM D1557) or (ASTM D698) _____
 Field Density, Soils (AASHTO T191, T205, or T310) _____
 Penetration Test, Soils _____

B. Aggregate Base:

Laboratory Compaction, (AASHTO T180) _____
 Field Density, (ASTM D1556) _____
 Aggregate, Base Course Gradation (AASHTO T27) _____
 Wear (AASHTO T96) _____
 Soundness (AASHTO T104) _____

C. Asphalt Concrete:

Field Density, (AASHTO T230) _____
 Aggregate, Asphalt Concrete Gradation (AASHTO T27) _____
 Wear (AASHTO T96) _____
 Soundness (AASHTO T104) _____

D. Concrete:

Making and Curing Concrete Test Cylinders (ASTM C31) _____
 Compressive Strength, Test Cylinders (ASTM C39) _____
 Concrete Slump Test (ASTM C143) _____
 Concrete Air Content Test (ASTM C173) _____
 Unit Weight, Lightweight Concrete (ASTM C567) _____
 Aggregate, Normal Weight: Gradation (ASTM C33) _____
 Deleterious Substances (ASTM C33) _____
 Soundness (ASTM C33) _____
 Abrasion (ASTM C33) _____
 Aggregate, Lightweight Gradation (ASTM C330) _____
 Deleterious Substances (ASTM C330) _____
 Unit Weight (ASTM C330) _____
 Flatness and Levelness Readings (ASTM E1155) (number of days) _____

E. Reinforcing Steel:

Tensile Test (ASTM A370) _____

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Bend Test (ASTM A370)

Mechanical Splice (ASTM A370)

Welded Splice Test (ASTM A370)

F. Structural Steel:

Ultrasonic Testing of Welds (ASTM E164)

Magnetic Particle Testing of Welds (ASTM E709)

Radiographic Testing of Welds (ASTM E94)

G. Inspection:

Technical Personnel (Man-days)

H. Technical Personnel:

1. Technicians to perform tests and inspection listed above. Laboratory will be equipped with concrete cylinder storage facilities, compression machine, cube molds, proctor molds, balances, scales, moisture ovens, slump cones, air meter, and all necessary equipment for compaction control.

- - - E N D - - -

SECTION 01 45 35
SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This guide specification will be applicable to both new buildings and existing building rehabilitations/renovations. In addition to the Special Inspection and testing specified requirements, a registered design professional must perform structural observations during construction. All observed deficiencies will be immediately reported to the Contracting Officer or the Contracting Officer's Representative (COR). The registered design professional performing these observations will be a representative of the Designer of Record (DOR) for the building being constructed.
- B. Structural observations are required for the following project conditions per IBC Chapter 17:
1. Seismic Design Category D, E or F; and assigned to Risk Cat III, IV or V.
 2. Seismic Design Category D, E or F; and with a height greater than 22860 mm 75 ft.
 3. Seismic Design Category E, assigned to Risk Category I or II and the building is greater than two stories above grade plane.
 4. Nominal design wind speed in excess of 49 m/sec 110 mph; and assigned to Risk Cat III, IV or V.
 5. Nominal design wind speed in excess of 49 m/sec 110 mph; and with a height greater than 23 m 75 ft.

1.2 APPLICABLE PUBLICATIONS

- A. The publication listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. American Society of Civil Engineers (ASCE)
1. ASCE 7 - (2010; Errata 2011; Supp 2 2013) Minimum Design Loads for Buildings and Other Structures
- C. International Code Council (ICC)
2. ICC IBC - (2015) International Building Code

1.3 GENERAL REQUIREMENTS

- A. Perform Special Inspections in accordance with the Statement of Special Inspections, Schedule of Special Inspections and Chapter 17 of ICC IBC. The Statement of Special Inspections and Schedule of Special Inspections are included as an attachment to this specification. Special Inspections are to be performed by an independent third party and are intended to ensure that the work of the prime contractor is in accordance with the Contract Documents and applicable building codes. Special inspections do not take the place of the three phases of control inspections performed by the Contractor's QC Manager or any testing and inspections required by other sections of the specifications.
- B. Structural observations will be performed by the Government. The contractor must provide notification to the COR 14 days prior to the following points of construction that structural observations need to occur:
- //1. The Government shall perform structural observations during construction on the following dates //____//
- //2. The Government shall perform structural observations during construction on the following dates //____//

1.4 DEFINITIONS

- A. Continuous Special Inspections - The constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks.
- B. Periodic Special Inspections - Special Inspections by the special inspector who is intermittently present where the work to be inspected has been or is being performed. Specific time interval on a specific Special Inspection should be indicated on the Schedule of Special Inspections.
- C. Perform - Perform these Special Inspections tasks for each welded joint or member.
- D. Observe - Observe these Special Inspections items on a random daily basis. Operations need not be delayed pending these inspections.
- E. Special Inspector (SI) - A qualified person retained by the contractor and approved by the COR as having the competence necessary to inspect a particular type of construction requiring Special Inspections. The SI

must be an independent third party hired directly by the Prime Contractor.

- F. Associate Special Inspector (ASI) - A qualified person who assists the SI in performing Special Inspections but must perform inspection under the direct supervision of the SI and cannot perform inspections without the SI on site.
- G. Third Party - A third party inspector must not be company employee of the Contractor or any Sub-Contractor performing the work to be inspected.
- H. Special Inspector of Record (SIOR) - SIOR must be an independent third party hired directly by the Prime Contractor and is required for the following project conditions:
 - 1. Seismic Design Category D, E, or F; and assigned to Risk Category III, IV, or V.
 - 2. Seismic Design Category D, E, or F; and with a height greater than 22860mm 75 ft.
 - 3. Seismic Design Category E, assigned to Risk Category I or II and the building is greater than two (2) stories above grade plane.
 - 4. Nominal design wind speed in excess of 49 m/sec 100 mph; and assigned to Risk Category III, IV, or V.
 - 5. Nominal design wind speed in excess of 49 mm/sec 100mph; and with a height greater than 23m 75ft.
 - 6. In addition to these conditions, the DOR is encouraged to consider using an SIOR on large magnitude or critical projects where this additional level of quality control is affordable.
- I. Contracting Officer - The Government official having overall authority for administrative contracting actions. Certain contracting actions may be delegated to the Contracting Officer's Representative (COR).
- J. Contractor's Quality Control (QC) Manager - An individual retained by the prime contractor and qualified in accordance with the Section 01 45 00.00 10 QUALITY CONTROL having the overall responsibility for the contractor's QC organization.
- K. Designer of Record (DOR) - A registered design professional is contracted by the Government as an A/E responsible for the overall design and review of submittal documents prepared by others. The DOR is registered or licensed to practice their respective design profession

as defined by the statutory requirements of the professional registration laws in state in which the design professional works. The DOR is also referred to as the Engineer of Record (EOR) in design code documents.

- L. Statement of Special Inspections (SSI) - A document developed by the DOR identifying the material, systems, components and work required to have Special Inspections and covering the following:
1. List of the Architectural Designated Seismic Systems - these components are in or attached to a Risk Category IV or V structure and are needed for continued operation of the facility or their failure could impair the continued operation of the facility.
 2. List of the Mechanical Designated Seismic Systems
 - a. For Seismic Design Category C or Risk V, list the following:
 - 1) Heating, ventilation, and air-conditioning (HVAC) ductwork containing hazardous materials and anchorage of such ductwork
 - 2) Piping systems and mechanical units containing flammable, combustible, or highly toxic materials.
 - b. For Seismic Design Category D, E, or F or Risk Category V list mechanical system that meet one of the following:
 - 1) Life safety component required to function after an earthquake
 - 2) Component that contains hazardous content,
 - 3) All components in an essential facility needed for continued operation after an earthquake.
 3. List of the Electrical Designated Systems
 - a. For Seismic Design Category C or Risk V, list the anchorage of electrical equipment used for emergency or standby power systems.
 - b. For Seismic Design Category D, E or F list electrical system that meet one of the following:
 - 1) Life safety component required to function after an earthquake
 - 2) Component that contains hazardous content,
 - 3) All components in an essential facility needed for continued operation after an earthquake.

4. List of elements that are part of the progressive collapse resistance system.
 - a. Provide a description of the following as they apply:
 - 1) Elements of the tie force system consisting of internal longitudinal and transverse, vertical, and peripheral ties.
 - 2) Elements of the alternate path system.
 - 3) Elements having enhanced local resistance. The Statement of Special Inspections and the Schedule of Special Inspections will be included as an attachment to this specification
 - a) Schedule of Special Inspections - A schedule which lists each of the required Special Inspections, the extent to which each Special Inspections is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17. Template found here:

 - b) Designated Seismic System - Those nonstructural components that require design in accordance with ASCE 7 Chapter 13 and for which the component importance factor, I_p , is greater than 1.0. This designation applies to systems that are required to be operational following the Design Earthquake for RC I - IV structures and following the MCER for RC V structures. All systems in RC V facilities designated as MC-1 in accordance with UFC 3-310-04 are considered part of the Designated Seismic Systems. Designated Seismic Systems will be identified by Owner and will have an Importance Factor $I_p = 1.5$
 - b. Submittals: Government approval is required for all submittals. CQC Special Inspection reports shall be submitted under this Specification section and follow the [Special Inspection]: [Applicable Specification section or description] naming convention. Submit the following:
 - 1) SD-01 Preconstruction Submittals;
 - 2) SIOR Letter of Acceptance;
 - 3) Special Inspections Project Manual;

- 4) Special Inspections Agency's Written Practices
 - 5) NDT Procedures and Equipment' Calibration Records;
 - 6) SD-06 Test Reports;
 - 7) Special Inspections
 - 8) Daily Reports;
 - 9) Special Inspections; Biweekly Reports;
 - 10) SD-07 Certificates;
 - 11) Fabrication Plant
 - 12) AC472 Accreditation;
 - 13) Steel Joist Institute Membership;
 - 14) Precast Concrete Institute (PCI) Certified Plant;
 - 15) Certificate of Compliance;
 - 16) Special Inspector of Record Qualifications;
 - 17) Special Inspector Qualifications;
 - 18) Qualification Records for NDT technicians;
 - 19) SD-11 Closeout Submittals;
 - 20) Interim Final Report of Special Inspections;
 - 21) Comprehensive Final Report of Special Inspections;
- c. Special Inspector Qualifications: Submit qualifications for each SI, ASI, and the SIOR from the following certifying associations: Associated Air Balance Council (AABC); American Concrete Institute (ACI); Association of the Wall and Ceiling Industry (AWCI); American Welding Society (AWS); Factory Mutual (FM); International Code Council (ICC); Nondestructive Testing (NDT); National Institute for Certification in Engineering Technologies (NICET); Precast/Prestressed Concrete Institute (PCI); Post-Tensioning Institute (PTI); Underwriters Laboratories (UL). Qualifications should be in accordance with the following minimums; PM or SRE can restrict qualifications to the higher standards shown if multiple options are shown for a role based on complexity of project.

QUALIFICATIONS

Area	Special Inspector	Associated Special Inspector	SIOR
Steel Construction and High Strength Bolting	ICC Structural Steel and Bolting Special Inspector certificate with on year of related experience, or Registered Professional Engineer with related experience.	Engineer-In-Training with one year of related experience.	
Welding Structural Steel (For highly complex steel use only AWS Certified Welding Inspectors)	ICC Welding Special Inspector certificate with one year of related experience or AWS Certified Welding Inspector	AWS Certified Associate Welding Inspector	
Nondestructive Testing of Welds	NDT Level II Certificate	NDT Level II Certificate plus one year of related experience	
Cold Formed Steel Framing	ICC Structural Steel and Bolting Special Inspector certificate with on year of related experience, or ICC Commercial Building Inspector with one year of experience; or Registered Professional Engineer with related experience.	Engineer-In-Training with one year of related experience.	
Concrete Construction	ICC Reinforced Concrete Special Inspector Certificate with one year of related experience, or ACI Concrete Construction Special Inspector, or NICET Concrete Technician Level III Certificate in Construction Materials Testing,	ACI Concrete Construction Special Inspector in Training, or Engineer-In-Training with one year of related experience	

Area	Special Inspector	Associated Special Inspector	SIOR
	or, Registered Professional Engineer with related experience		
Verification of Site Soil Condition, Fill Placement, and Load-Bearing Requirements	ICC Soils Special Inspector Certificate with one year of related experience, or NICET Soils Technician Level II Certificate in Construction Material Testing, or NICET Geotechnical Engineering Technician Level II Construction or Generalist Certificate, or Geologist-In-Training with one year of related experience, or Registered Professional Engineer with related experience	NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or NICET Geotechnical Engineering Technician Level I Construction, or Generalist Certificate with one year of related experience, or Engineer-In-Training with one year of related experience	

PART 2 - PRODUCTS**2.1 FABRICATORS SPECIAL INSPECTION**

- A. Special Inspections of fabricator's work performed in the fabricator's shop is required to be inspected in accordance with the Statement of Special Inspections and the Schedule of Special Inspections unless the fabricator is certified by the approved agency to perform such work without Special Inspections. Submit the applicable certification(s) from the following list to the COR for information to allow work performed in the fabricator's shop to not be subjected to Special Inspections.
- B. The following certifications meet the requirements for fabricator approval in accordance with paragraph 1704.2.5.2 of IBC:
1. American Institute of Steel Construction (AISC) Certified Fabrication Plant, Category STD.
 2. Truss Plate Institute (TPI) steel truss plate quality assurance program certification.
 3. Truss Plate Institute (TPI) wood truss plate quality assurance program certification.
 4. International Accreditation Service, AC472 Accreditation Steel Joist Institute Membership
 5. Precast Concrete Institute (PCI) Certified Plant, Group C
- C. At the completion of fabrication, submit a certificate of compliance, to be included with the comprehensive final report of Special **Inspections, stating that the materials supplied and work performed by the fabricator are in accordance the construction documents.**

PART 3 - EXECUTION**3.1 RESPONSIBILIES MATRIX**

Inspector	Responsibility	Condition
SIOR	a. Supervise all Special Inspectors required by the contract documents and the IBC. b. Submit a SIOR Letter of Acceptance to the COR attesting to acceptance of the duties of SIOR, signed and sealed by the SIOR. c. Verify the qualifications of all of the Special Inspectors.	Applicable when SIOR is required

Inspector	Responsibility	Condition
	d. Verify the qualifications of fabricators.	
	e. Submit Special Inspections agency's written practices for the monitoring and control of the agency's operations to include the following: <ol style="list-style-type: none"> 1. The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and examination requirements for qualifications and certification of inspection personnel. 2. The agency's inspection procedures, including general inspection, material controls, and visual welding inspection. f. Submit qualification records for nondestructive testing (NDT) technicians designated for the project. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.	Applicable when SIOR is required and when the structural design is required to follow AISC341 for seismic design of steel structures
	g. Prepare a Special Inspections Project Manual, which will cover the following: <ol style="list-style-type: none"> 1. Roles and responsibilities of the following individuals during Special Inspections: SIOR, SI, General Contractor, Subcontractors, QC Manager, and DOR. 2. Organizational chart and/or communication plan, indicating lines of communication 3. Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors. Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors. 4. Indicate the government reporting procedures. 5. Propose forms or templates to be used by SI and SIOR to document inspections. 6. Indicate procedures for tracking nonconforming work and verification that corrective work is complete. 7. Indicate how the SIOR and/or SI will participate in weekly QC meetings. 8. Indicate how Special Inspections of shop fabricated items will be handled when the 	Applicable when SIOR is required

Inspector	Responsibility	Condition
	<p>fabricator's shop is not certified per paragraph FABRICATOR SPECIAL INSPECTIONS.</p> <p>9. Include a section in the manual that covers each specific item requiring Special Inspections that is indicated on the Schedule of Special Inspections. Provide names and qualifications of each special inspector who will be performing the Special Inspections for each specific item. Provide detail on how the Special Inspections are to be carried out for each item so that the expectations are clear for the General Contractor and the Subcontractor performing the work. Make a copy of the Special Inspections Project Manual available on the job site during construction. Submit a copy of the Special Inspections Project Manual for approval.</p> <p>h. Attend coordination and mutual understanding meeting where the information in the Special Inspections Project Manual will be reviewed to verify that all parties have a clear understanding of the Special Inspections provisions and the individual duties and responsibilities of each party.</p> <p>i. Maintain a 3- ring binder for the Special Inspector's daily and biweekly reports and the Special Inspections Project Manual. This file must be located in a conspicuous place in the project trailer/office to allow review by the COR and the DOR.</p> <p>j. Submit a copy of the Special Inspector's daily reports to the QC Manager.</p> <p>k. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.</p> <p>l. Submit a biweekly Special Inspections report until all work requiring Special Inspections is complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:</p> <ol style="list-style-type: none"> 1. A brief summary of the work performed during the reporting time frame. 2. Changes and/or discrepancies with the drawings, specifications, and mechanical or electrical component certification if they 	

Inspector	Responsibility	Condition
	<p>require seismic systems, that were observed during the reporting period.</p> <p>3. Discrepancies which were resolved or corrected.</p> <p>4. A list of nonconforming items requiring resolution.</p> <p>5. All applicable test results including nondestructive testing reports.</p> <p>m. For large, complex projects, at the completion of each Definable Feature of Work (DFOW) requiring Special Inspections, submit an interim final report of Special Inspections that documents the Special Inspections completed for that DFOW and corrections of all discrepancies noted in the daily reports. The interim final report of Special Inspections must be signed, dated and bear the seal of the SIOR.].</p>	
QC Manager	<p>a. If there is no SIOR, QC Manager must Supervise all Special Inspectors required by the contract documents and the IBC; Verify the qualifications of all of the Special Inspectors; Verify the qualifications of fabricators; Maintain a 3-ring binder for the Special Inspector's daily and biweekly reports. This file must be located in a conspicuous place in the project trailer/office to allow review by the COR and the DOR.</p>	Applicable when SIOR is not required
	<p>b. Maintain a rework items list that includes discrepancies noted on the Special Inspectors daily report.</p>	n/a
Special Inspectors	<p>a. Inspect all elements of the project for which the special inspector is qualified to inspect and are identified in the Schedule of Special Inspections.</p> <p>b. Attend preparatory phase meetings related to the Definable Feature of Work (DFOW) for which the special inspector is qualified to inspect.</p>	
	<p>c. Submit Special Inspections agency's written practices for the monitoring and control of the agency's operations to include the following:</p> <p>1. The agency's procedures for the selection and administration of inspection personnel, describing the training, experience and</p>	Applicable when SIOR is NOT required and when the structural design is required to follow AISC

Inspector	Responsibility	Condition
	<p>examination requirements for qualifications and certification of inspection personnel.</p> <p>2. The agency's inspection procedures, including general inspection, material controls, and visual welding inspection.</p> <p>d. Submit qualification records for nondestructive testing (NDT) technicians designated for the project.</p> <p>e. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.]</p>	341 for seismic design of steel structures
	<p>f. Submit a copy of the daily reports to the QC Manager.</p> <p>g. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.</p> <p>h. Submit a biweekly Special Inspection Report until all inspections are complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:</p> <ol style="list-style-type: none"> 1. A brief summary of the work performed during the reporting time frame 2. Changes and/or discrepancies with the drawings, specifications, and mechanical or electrical component certification if they require seismic systems that were observed during the reporting period. 3. Discrepancies which were resolved or corrected. 4. A list of nonconforming items requiring resolution. 5. All applicable test result including nondestructive testing reports. <p>i. For large, complex projects, at the completion of each Definable Feature of Work (DFOW) requiring Special Inspections, submit an interim final report of Special Inspections that documents the Special Inspections completed for that DFOW and corrections of all discrepancies noted in the daily reports. The interim final report of Special Inspections</p>	Applicable when SIOR is not required

Inspector	Responsibility	Condition
	<p>must be signed, dated and bear the seal of the SIOR.]</p> <p>j. At the completion of the project submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and indicate the certification of the special inspector qualifying them to conduct the inspection.</p>	
	k. Submit daily reports to the SIOR	Applicable when SIOR is required

3.2 DEFECTIVE WORK

Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate the Government to accept such work.

-- End of Section -

SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the control of environmental pollution and damage that the Contractor must consider for air, water, and land resources. It includes management of visual aesthetics, noise, solid waste, radiant energy, and radioactive materials, as well as other pollutants and resources encountered or generated by the Contractor. The Contractor is obligated to consider specified control measures with the costs included within the various contract items of work.
- B. Environmental pollution and damage is defined as the presence of chemical, physical, or biological elements or agents which:
1. Adversely effect human health or welfare,
 2. Unfavorably alter ecological balances of importance to human life,
 3. Effect other species of importance to humankind, or;
 4. Degrade the utility of the environment for aesthetic, cultural, and historical purposes.
- C. Definitions of Pollutants:
1. Chemical Waste: Petroleum products, bituminous materials, salts, acids, alkalis, herbicides, pesticides, organic chemicals, and inorganic wastes.
 2. Debris: Combustible and noncombustible wastes, such as leaves, tree trimmings, ashes, and waste materials resulting from construction or maintenance and repair work.
 3. Sediment: Soil and other debris that has been eroded and transported by runoff water.
 4. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
 5. Surface Discharge: The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "water of the United States" and would require a permit to discharge water from the governing agency.
 6. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass and crockery, metal and lumber scrap, tin cans, and bones.

7. Sanitary Wastes:

- a. Sewage: Domestic sanitary sewage and human and animal waste.
- b. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2 QUALITY CONTROL

- A. Establish and maintain quality control for the environmental protection of all items set forth herein.
- B. Record on daily reports any problems in complying with laws, regulations, and ordinances. Note any corrective action taken.

1.3 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. U.S. National Archives and Records Administration (NARA):
33 CFR 328.....Definitions

1.4 SUBMITTALS

- A. In accordance with Section, 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish the following:
 - 1. Environmental Protection Plan: After the contract is awarded and prior to the commencement of the work, the Contractor shall meet with the Resident Engineer to discuss the proposed Environmental Protection Plan and to develop mutual understanding relative to details of environmental protection. Not more than 20 days after the meeting, the Contractor shall prepare and submit to the VHA COR for approval, a written and/or graphic Environmental Protection Plan including, but not limited to, the following:
 - a. Name(s) of person(s) within the Contractor's organization who is (are) responsible for ensuring adherence to the Environmental Protection Plan.
 - b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site.
 - c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.
 - d. Description of the Contractor's environmental protection personnel training program.
 - e. A list of Federal, State, and local laws, regulations, and permits concerning environmental protection, pollution control, noise control and abatement that are applicable to the Contractor's

proposed operations and the requirements imposed by those laws, regulations, and permits.

- f. Methods for protection of features to be preserved within authorized work areas including trees, shrubs, vines, grasses, ground cover, landscape features, air and water quality, fish and wildlife, soil, historical, and archeological and cultural resources.
 - g. Procedures to provide the environmental protection that comply with the applicable laws and regulations. Describe the procedures to correct pollution of the environment due to accident, natural causes, or failure to follow the procedures as described in the Environmental Protection Plan.
 - h. Permits, licenses, and the location of the solid waste disposal area.
 - i. Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials. Include as part of an Erosion Control Plan approved by the District Office of the U.S. Soil Conservation Service and the Department of Veterans Affairs.
 - j. Environmental Monitoring Plans for the job site including land, water, air, and noise.
 - k. Work Area Plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas. This plan may be incorporated within the Erosion Control Plan.
- B. Approval of the Contractor's Environmental Protection Plan will not relieve the Contractor of responsibility for adequate and continued control of pollutants and other environmental protection measures.

1.5 PROTECTION OF ENVIRONMENTAL RESOURCES

- A. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this contract. Confine activities to areas defined by the specifications and drawings.
- B. Protection of Land Resources: Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, top soil, and land forms without permission from the Resident Engineer. Do not fasten or attach ropes, cables, or guys to

trees for anchorage unless specifically authorized, or where special emergency use is permitted.

1. **Work Area Limits:** Prior to any construction, mark the areas that require work to be performed under this contract. Mark or fence isolated areas within the general work area that are to be saved and protected. Protect monuments, works of art, and markers before construction operations begin. Convey to all personnel the purpose of marking and protecting all necessary objects.
2. **Protection of Landscape:** Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using any other approved techniques.
 - a. Box and protect from damage existing trees and shrubs to remain on the construction site.
 - b. Immediately repair all damage to existing trees and shrubs by trimming, cleaning, and painting with antiseptic tree paint.
 - c. Do not store building materials or perform construction activities closer to existing trees or shrubs than the farthest extension of their limbs.
3. **Reduction of Exposure of Unprotected Erodible Soils:** Plan and conduct earthwork to minimize the duration of exposure of unprotected soils. Clear areas in reasonably sized increments only as needed to use. Form earthwork to final grade as shown. Immediately protect side slopes and back slopes upon completion of rough grading.
4. **Temporary Protection of Disturbed Areas:** Construct diversion ditches, benches, and berms to retard and divert runoff from the construction site to protected drainage areas approved under paragraph 208 of the Clean Water Act.
 - a. **Sediment Basins:** Trap sediment from construction areas in temporary or permanent sediment basins that accommodate the runoff of a local 25 (design year) storm. After each storm, pump the basins dry and remove the accumulated sediment. Control overflow/drainage with paved weirs or by vertical overflow pipes, draining from the surface.
 - b. Reuse or conserve the collected topsoil sediment as directed by the Resident Engineer. Topsoil use and requirements are specified in Section 31 20 00, EARTH MOVING.
 - c. Institute effluent quality monitoring programs as required by Federal, State, and local environmental agencies.

5. Erosion and Sedimentation Control Devices: The erosion and sediment controls selected and maintained by the Contractor shall be such that water quality standards are not violated as a result of the Contractor's activities. Construct or install all temporary and permanent erosion and sedimentation control features. Maintain temporary erosion and sediment control measures such as berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
 6. Manage borrow areas on and off Government property to minimize erosion and to prevent sediment from entering nearby water courses or lakes.
 7. Manage and control spoil areas on Government property to limit spoil to areas on the Environmental Protection Plan and prevent erosion of soil or sediment from entering nearby water courses or lakes.
 8. Protect adjacent areas from despoilment by temporary excavations and embankments.
 9. Handle and dispose of solid wastes in such a manner that will prevent contamination of the environment. Place solid wastes (excluding clearing debris) in containers that are emptied on a regular schedule. Transport all solid waste off Government property and dispose of waste in compliance with Federal, State, and local requirements.
 10. Store chemical waste away from the work areas in corrosion resistant containers and dispose of waste in accordance with Federal, State, and local regulations.
 11. Handle discarded materials other than those included in the solid waste category as directed by the Resident Engineer.
- C. Protection of Water Resources: Keep construction activities under surveillance, management, and control to avoid pollution of surface and ground waters and sewer systems. Implement management techniques to control water pollution by the listed construction activities that are included in this contract.
1. Washing and Curing Water: Do not allow wastewater directly derived from construction activities to enter water areas. Collect and place wastewater in retention ponds allowing the suspended material to settle, the pollutants to separate, or the water to evaporate.
 2. Control movement of materials and equipment at stream crossings during construction to prevent violation of water pollution control standards of the Federal, State, or local government.

3. Monitor water areas affected by construction.
- D. Protection of Fish and Wildlife Resources: Keep construction activities under surveillance, management, and control to minimize interference with, disturbance of, or damage to fish and wildlife. Prior to beginning construction operations, list species that require specific attention along with measures for their protection.
- E. Protection of Air Resources: Keep construction activities under surveillance, management, and control to minimize pollution of air resources. Burning is not permitted on the job site. Keep activities, equipment, processes, and work operated or performed, in strict accordance with the State of Wyoming and Federal emission and performance laws and standards. Maintain ambient air quality standards set by the Environmental Protection Agency, for those construction operations and activities specified.
1. Particulates: Control dust particles, aerosols, and gaseous by-products from all construction activities, processing, and preparation of materials (such as from asphaltic batch plants) at all times, including weekends, holidays, and hours when work is not in progress.
 2. Particulates Control: Maintain all excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and all other work areas within or outside the project boundaries free from particulates which would cause a hazard or a nuisance. Sprinklering, chemical treatment of an approved type, light bituminous treatment, baghouse, scrubbers, electrostatic precipitators, or other methods are permitted to control particulates in the work area.
 3. Hydrocarbons and Carbon Monoxide: Control monoxide emissions from equipment to Federal and State allowable limits.
 4. Odors: Control odors of construction activities and prevent obnoxious odors from occurring.
- F. Reduction of Noise: Minimize noise using every action possible. Perform noise-producing work in less sensitive hours of the day or week as directed by the Resident Engineer. Maintain noise-produced work at or below the decibel levels and within the time periods specified.
1. Perform construction activities involving repetitive, high-level impact noise only between 7:00 a.m. and 6:00 p.m unless otherwise permitted by local ordinance or the Resident Engineer. Repetitive

impact noise on the property shall not exceed the following dB limitations:

Time Duration of Impact Noise	Sound Level in dB
More than 12 minutes in any hour	70
Less than 30 seconds of any hour	85
Less than three minutes of any hour	80
Less than 12 minutes of any hour	75

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

EARTHMOVING		MATERIALS HANDLING	
FRONT LOADERS	75	CONCRETE MIXERS	75
BACKHOES	75	CONCRETE PUMPS	75
DOZERS	75	CRANES	75
TRACTORS	75	DERRICKS IMPACT	75
SCAPERS	80	PILE DRIVERS	95
GRADERS	75	JACK HAMMERS	75
TRUCKS	75	ROCK DRILLS	80
PAVERS, STATIONARY	80	PNEUMATIC TOOLS	80
PUMPS	75	BLASTING	NA
GENERATORS	75	SAWS	75
COMPRESSORS	75	VIBRATORS	75

- b. Use shields or other physical barriers to restrict noise transmission.
- c. Provide soundproof housings or enclosures for noise-producing machinery.
- d. Use efficient silencers on equipment air intakes.
- e. Use efficient intake and exhaust mufflers on internal combustion engines that are maintained so equipment performs below noise levels specified.
- f. Line hoppers and storage bins with sound deadening material.
- g. Conduct truck loading, unloading, and hauling operations so that noise is kept to a minimum.
3. Measure sound level for noise exposure due to the construction at least once every five successive working days while work is being

- performed above 55 dB(A) noise level. Measure noise exposure at the property line or 15 m (50 feet) from the noise source, whichever is greater. Measure the sound levels on the A weighing network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, take measurements at 900 to 1800 mm (three to six feet) in front of any building face. Submit the recorded information to the Resident Engineer noting any problems and the alternatives for mitigating actions.
- G. Restoration of Damaged Property: If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the Contractor shall restore the damaged property to a condition equal to that existing before the damage at no additional cost to the Government. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.
- H. Final Clean-up: On completion of project and after removal of all debris, rubbish, and temporary construction, Contractor shall leave the construction area in a clean condition satisfactory to the Resident Engineer. Cleaning shall include off the station disposal of all items and materials not required to be salvaged, as well as all debris and rubbish resulting from demolition and new work operations.

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SECTION 01 81 13
SUSTAINABLE CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section describes general requirements and procedures to comply with federal mandates and U.S. Department of Veterans Affairs (VA) policies for sustainable construction.
- B. The Design Professional has selected materials and utilized integrated design processes that achieve the Government's objectives. Contractor is responsible to maintain and support these objectives in developing means and methods for performing work and in proposing product substitutions or changes to specified processes. Obtain approval from Contracting Officer for all changes and substitutions to materials or processes. Proposed changes must meet, or exceed, materials or processes specified.

1.2 RELATED WORK

- A. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.3 DEFINITIONS

- A. Recycled Content: Recycled content of materials is defined according to Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260). Recycled content value of a material assembly is determined by weight. Recycled fraction of assembly is multiplied by cost of assembly to determine recycled content value.
 - 1. "Post-Consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
 - 2. "Pre-Consumer" material is defined as material diverted from waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.
- B. Biobased Products: Biobased products are derived from plants and other renewable agricultural, marine, and forestry materials and provide an alternative to conventional petroleum derived products. Biobased

products include diverse categories such as lubricants, cleaning products, inks, fertilizers, and bioplastics.

- C. Low Pollutant-Emitting Materials: Materials and products which are minimally odorous, irritating, or harmful to comfort and well-being of installers and occupants.
- D. Volatile Organic Compounds (VOC): Chemicals that are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects.

1.4 REFERENCE STANDARDS

- A. Carpet and Rug Institute Green Label Plus program.
- B. U.S. Department of Agriculture BioPreferred program (USDA BioPreferred).
- C. U.S. Environmental Protection Agency Comprehensive Procurement Guidelines (CPG).
- D. U.S. Environmental Protection Agency WaterSense Program (WaterSense).
- E. U.S. Environmental Protection Agency ENERGY STAR Program (ENERGY STAR).
- F. U. S. Department of Energy Federal Energy Management Program (FEMP).
- G. Green Electronic Council EPEAT Program (EPEAT).

1.5 SUBMITTALS

- A. All submittals to be provided by contractor to COR.
- B. Sustainability Action Plan:
 - 1. Submit documentation as required by this section; provide additional copies of typical submittals required under technical sections when sustainable construction requires copies of record submittals.
 - 2. Within 30 days after Preconstruction Meeting provide a narrative plan for complying with requirements stipulated within this section.
 - 3. Sustainability Action Plan must:
 - a. Make reference to sustainable construction submittals defined by this section.
 - b. Address all items listed under PERFORMANCE CRITERIA.
 - c. Indicate individual(s) responsible for implementing the plan.
- C. Low Pollutant-Emitting Materials Tracking Spreadsheet: Within 30 days after Preconstruction Meeting provide a preliminary Low Pollutant-Emitting Materials Tracking Spreadsheet. The Low Pollutant-Emitting Materials Tracking Spreadsheet must be an electronic file and include

all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.

D. Construction Indoor Air Quality (IAQ) Management Plan:

1. Not more than 30 days after Preconstruction Meeting provide a Construction IAQ Management Plan as an electronic file including descriptions of the following:
 - a. Instruction procedures for meeting or exceeding minimum requirements of ANSI/SMACNA 008-2008, Chapter 3, including procedures for HVAC Protection, Source Control, Pathway Interruption, Housekeeping, and Scheduling.
 - b. Instruction procedures for protecting absorptive materials stored on-site or installed from moisture damage.
 - c. Instruction procedures if air handlers must be used during construction, including a description of filtration media to be used at each return air grille.
 - d. Instruction procedure for replacing all air-filtration media immediately prior to occupancy after completion of construction, including a description of filtration media to be used at each air handling or air supply unit.

E. Product Submittals:

1. Recycled Content: Submit product data from manufacturer indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content (excluding MEP systems equipment and components).
2. Biobased Content: Submit product data for products to be installed or used which are included in any of the USDA BioPreferred program's product categories. Data to include percentage of biobased content and source of biobased material.
3. Low Pollutant-Emitting Materials: Submit product data confirming compliance with relevant requirements for all materials on Project in categories described under Low Pollutant-Emitting Materials in 01 81 13.
4. For applicable products and equipment, submit product documentation confirming ENERGY STAR label, FEMP certification, WaterSense, and/or EPEAT certification.

- F. Sustainable Construction Progress Reports: Concurrent with each Application for Payment, submit a Sustainable Construction Progress Report to confirm adherence with Sustainability Action Plan.
1. Include narratives of revised strategies for bringing work progress into compliance with plan and product submittal data.
 2. Include updated and current Low Pollutant-Emitting Materials Tracking Spreadsheet.
 3. Include construction waste tracking, in tons or cubic yards, including waste description, whether diverted or landfilled, hauler, and percent diverted for comingled quantities; and excluding land-clearing debris and soil. Provide haul receipts and documentation of diverted percentages for comingled wastes.
- G. Closeout Submittals: Within 14 days after Substantial Completion provide the following:
1. Final version of Low Pollutant-Emitting Materials Tracking Spreadsheet.
 2. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for filtration media installed at return air grilles during construction if permanently installed air handling units are used during construction.
 3. Manufacturer's cut sheets and product data highlighting the Minimum Efficiency Reporting Value (MERV) for final filtration media in air handling units.
 4. Minimum 18 construction photographs including six photographs taken on three different occasions during construction of ANSI/SMACNA 008-2008, Chapter 3 approaches employed, along with a brief description of each approach, documenting implementation of IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.
 5. Flush-out Documentation:
 - a. Product data for filtration media used during flush-out.
 - b. Product data for filtration media installed immediately prior to occupancy.
 - c. Signed statement describing building air flush-out procedures including dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.

1.6 QUALITY ASSURANCE

- A. Preconstruction Meeting: After award of Contract and prior to commencement of Work, schedule and conduct meeting with COR to discuss the Project Sustainable Action Plan content as it applies to submittals, project delivery, required Construction Indoor Air Quality (IAQ) Management Plan, and other Sustainable Construction Requirements. The purpose of this meeting is to develop a mutual understanding of the Sustainable Construction Requirements and coordination of contractor's management of these requirements with the Contracting Officer and the Construction Quality Manager.
- B. Construction Job Conferences: Status of compliance with Sustainable Construction Requirements of these specifications will be an agenda item at regular job meetings conducted during the course of work at the site.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
- B. Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- C. Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- D. Green Seal Standard GC-36, Commercial Adhesives, October 19, 2000.
- E. South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- F. South Coast Air Quality Management District (SCAQMD) Rule 1168, July 1, 2005 and rule amendment date of January 7, 2005.
- G. Sheet Metal and Air Conditioning National Contractors' Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd Edition (ANSI/SMACNA 008-2008), Chapter 3.
- H. California Department of Public Health Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1, Emission Testing method for California Specification 01350 (CDPH Standard Method V1.1-2010).

- I. Federal Trade Commission Guides for the Use of Environmental Marketing Claims (16 CFR Part 260).
- J. ASHRAE Standard 52.2-2007.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

- A. Construction waste diversion from landfill disposal must comprise at least 50 percent of total construction waste, excluding land clearing debris and soil. Alternative daily cover (ADC) does not qualify as material diverted from disposal.
- B. Low Pollutant-Emitting Materials:
 - 1. Adhesives, sealants and sealant primers applied on site within the weatherproofing membrane must comply with VOC limits of SCAQMD Rule 1168:
 - a. Flooring Adhesives and Sealants:
 - 1) Indoor carpet adhesives: 50 g/L.
 - 2) Wood Flooring Adhesive: 100 g/L.
 - 3) Rubber Floor Adhesives: 60 g/L.
 - 4) Subfloor Adhesives: 50 g/L.
 - 5) Ceramic Tile Adhesives and Grout: 65 g/L.
 - 6) Cove Base Adhesives: 50 g/L.
 - 7) Multipurpose Construction Adhesives: 70 g/L.
 - 8) Porous Material (Except Wood) Substrate: 50 g/L.
 - 9) Wood Substrate: 30 g/L.
 - 10) Architectural Non-Porous Sealant Primer: 250 g/L.
 - 11) Architectural Porous Sealant Primer: 775 g/L.
 - 12) Other Sealant Primer: 750 g/L.
 - 13) Structural Wood Member Adhesive: 140 g/L.
 - 14) Sheet-Applied Rubber Lining Operations: 850 g/L.
 - 15) Top and Trim Adhesive: 250 g/L.
 - 16) Architectural Sealant: 250 g/L.
 - 17) Other Sealant: 420 g/L.
 - b. Non-Flooring Adhesives and Sealants:
 - 1) Drywall and Panel Adhesives: 50 g/L.
 - 2) Multipurpose Construction Adhesives: 70 g/L.
 - 3) Structural Glazing Adhesives: 100 g/L.
 - 4) Metal-to-Metal Substrate Adhesives: 30 g/L.

- 5) Plastic Foam Substrate Adhesive: 50 g/L.
 - 6) Porous Material (Except Wood) Substrate Adhesive: 50 g/L.
 - 7) Wood Substrate Adhesive: 30 g/L.
 - 8) Fiberglass Substrate Adhesive: 80 g/L.
 - 9) Architectural Non-Porous Sealant Primer: 250 g/L.
 - 10) Architectural Porous Sealant Primer: 775 g/L.
 - 11) Other Sealant Primer: 750 g/L.
 - 12) PVC Welding Adhesives: 510 g/L.
 - 13) CPVC Welding Adhesives: 490 g/L.
 - 14) ABS Welding Adhesives: 325 g/L.
 - 15) Plastic Cement Welding Adhesives: 250 g/L.
 - 16) Adhesive Primer for Plastic: 550 g/L.
 - 17) Contact Adhesive: 80 g/L.
 - 18) Special Purpose Contact Adhesive: 250 g/L.
 - 19) Structural Wood Member Adhesive: 140 g/L.
 - 20) Sheet Applied Rubber Lining Operations: 850 g/L.
 - 21) Top and Trim Adhesive: 250 g/L.
 - 22) Architectural Sealants: 250 g/L.
 - 23) Other Sealants: 420 g/L.
2. Aerosol adhesives applied on site within the weatherproofing membrane must comply with the following Green Seal GS-36.
 - a. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent VOCs by weight.
 - b. Aerosol Adhesive, General-Purpose Web Spray: 55 percent VOCs by weight.
 - c. Special-Purpose Aerosol Adhesive (All Types): 70 percent VOCs by weight.
 3. Paints and coatings applied on site within the weatherproofing membrane must comply with the following criteria:
 - a. VOC content limits for paints and coatings established in Green Seal Standard GS-11.
 - b. VOC content limit for anti-corrosive and anti-rust paints applied to interior ferrous metal substrates of 250 g/L established in Green Seal GC-03.

- c. Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed VOC content limits established in SCAQMD Rule 1113.
- d. Comply with the following VOC content limits:
 - 1) Anti-Corrosive/Antirust Paints: 250 g/L.
 - 2) Clear Wood Finish, Lacquer: 550 g/L.
 - 3) Clear Wood Finish, Sanding Sealer: 350 g/L.
 - 4) Clear Wood Finish, Varnish: 350 g/L.
 - 5) Floor Coating: 100 g/L.
 - 6) Interior Flat Paint, Coating or Primer: 50 g/L.
 - 7) Interior Non-Flat Paint, Coating or Primer: 150 g/L.
 - 8) Sealers and Undercoaters: 200 g/L.
 - 9) Shellac, Clear: 730 g/L.
 - 10) Shellac, Pigmented: 550 g/L.
 - 11) Stain: 250 g/L.
 - 12) Clear Brushing Lacquer: 680 g/L.
 - 13) Concrete Curing Compounds: 350 g/L.
 - 14) Japans/Faux Finishing Coatings: 350 g/L.
 - 15) Magnesite Cement Coatings: 450 g/L.
 - 16) Pigmented Lacquer: 550 g/L.
 - 17) Waterproofing Sealers: 250 g/L.
 - 18) Wood Preservatives: 350 g/L.
 - 19) Low-Solids Coatings: 120 g/L.
- 4. Each non-carpet flooring element installed in building interior which is not inherently non-emitting (stone, ceramic, powder-coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring) must comply with one of the following:
 - a. Meet requirements of the FloorScore standard as shown with testing by an independent third-party.
 - b. Maximum VOC concentrations specified in CDPH Standard Method V1.1-2010, using office scenario at 14 day time point.
- 5. Composite wood and agrifiber products used within the weatherproofing membrane must contain no added urea-formaldehyde resins.

6. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde.

C. Recycled Content:

1. Any products being installed or used that are listed on EPA Comprehensive Procurement Guidelines designated product list must meet or exceed the EPA's recycled content recommendations. The EPA Comprehensive Procurement Guidelines categories include:
 - a. Building insulation.
 - b. Cement and concrete.
 - c. Consolidated and reprocessed latex paint.
 - d. Floor tiles.
 - e. Flowable fill.
 - f. Laminated paperboard.
 - g. Modular threshold ramps.
 - h. Non-pressure pipe.
 - i. Roofing materials.
 - j. Shower and restroom dividers/partitions.
 - k. Structural fiberboard.
 - l. Compost and fertilizer made from recovered organic materials.
 - m. Hydraulic mulch.
 - n. Lawn and garden edging.
 - o. Plastic lumber landscaping timbers and posts.

D. Biobased Content:

1. Materials and equipment being installed or used that are listed on the USDA BioPreferred program product category list must meet or exceed USDA's minimum biobased content threshold. Refer to individual specification sections for detailed requirements applicable to that section.
 - a. USDA BioPreferred program categories include:
 - 1) Adhesive and Mastic Removers.
 - 2) Carpets.
 - 3) Cleaners.
 - 4) Composite Panels.
 - 5) Corrosion Preventatives.
 - 6) Erosion Control Materials.

- 7) Dust Suppressants.
- 8) Fertilizers.
- 9) Floor Cleaners and Protectors.
- 10) Floor Coverings (Non-Carpet).
- 11) Glass Cleaners.
- 12) Hydraulic Fluids.
- 13) Industrial Cleaners.
- 14) Interior Paints and Coatings.
- 15) Mulch and Compost Materials.
- 16) Multipurpose Cleaners.
- 17) Multipurpose Lubricants.
- 18) Packaging Films.
- 19) Paint Removers.
- 20) Plastic Insulating Foam.
- 21) Pneumatic Equipment Lubricants.
- 22) Roof Coatings.
- 23) Wastewater Systems Coatings.
- 24) Water Tank Coatings.
- 25) Wood and Concrete Sealers.
- 26) Wood and Concrete Stains.

E. Materials, products, and equipment being installed which fall into a category covered by the WaterSense program must be WaterSense-labeled or meet or exceed WaterSense program performance requirements, unless disallowed for infection control reasons.

1. WaterSense categories include:

- a. Bathroom Faucets
- b. Commercial Toilets
- c. Irrigation Controllers
- d. Pre-Rinse Spray Valves
- e. Showerheads
- f. Spray Sprinkler Bodies
- g. Urinals

F. Materials, products, and equipment being installed which fall into any of the following product categories must be Energy Star-labeled.

1. Applicable Energy Star product categories as of 09/14/2017 include:

- a. Appliances:

- 1) Air Purifiers and Cleaners.
- 2) Dehumidifiers.
- b. Electronics and Information Technology:
 - 1) Audio/Video Equipment.
 - 2) Computers.
 - 3) Data Center Storage.
 - 4) Digital Media Player.
 - 5) Enterprise Servers.
 - 6) Imaging Equipment.
 - 7) Monitors.
 - 8) Professional Displays.
 - 9) Set-Top and Cable Boxes.
 - 10) Telephones.
 - 11) Televisions.
 - 12) Uninterruptible Power Supplies.
 - 13) Voice over Internet Protocol (VoIP) Phones.
- c. Heating and Cooling Equipment:
 - 1) Boilers.
 - 2) Water Heaters.
 - 3) Light Commercial Heating and Cooling Equipment.
- d. Other:
 - 1) Decorative Light Strings.
 - 2) Electric Vehicle Supply Equipment.
 - 3) Laboratory-Grade Refrigerators and Freezers.
 - 4) Light Bulbs.
 - 5) Light Fixtures.
 - 6) Roof Products.
 - 7) Water Coolers.
 - 8) Windows, Doors, and Skylights.
- G. Materials, products, and equipment being installed which fall into any of the following categories must be FEMP-designated. FEMP-designated product categories as of 09/14/2017 include:
 1. Boilers (Commercial).
 2. Electric Chillers, Air-Cooled (Commercial).
 3. Electric Chillers, Water-Cooled (Commercial).
 4. Exterior Lighting.

5. Fluorescent Ballasts.
 6. Fluorescent Lamps, General Service.
 7. Ice Machines, Water-Cooled.
 8. Industrial Lighting (High/Low Bay).
 9. Light Emitting Diode (LED) Luminaires.
- H. Electronic products and equipment being installed which fall into any of the following categories shall be EPEAT registered. Electronic products and equipment covered by EPEAT program as of 09/14/2017 include:
1. Computers.
 2. Displays.
 3. Imaging Equipment.
 4. Televisions.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Construction Indoor Air Quality Management:
1. During construction, meet or exceed recommended control measures of ANSI/SMACNA 008-2008, Chapter 3.
 2. Protect stored on-site and installed absorptive materials from moisture damage.
 3. If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda). Replace all filtration media immediately prior to occupancy.
 4. Perform building flush-out as follows:
 - a. After construction ends, prior to occupancy and with interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. of outdoor air per sq. ft. of floor area while maintaining an internal temperature of at least 60 degrees Fahrenheit and a relative humidity no higher than 60 percent. OR
 - b. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of floor area to the space. Once a space is occupied, it must be ventilated at a minimum rate of

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0.30 cfm per sq. ft. of outside air or design minimum outside air rate determined until a total of 14000 cu. ft./sq. ft. of outside air has been delivered to the space. During each day of flush-out period, ventilation must begin a minimum of three hours prior to occupancy and continue during occupancy.

5. Provide construction dust control to comply with SCAQMD Rule 403.

-----END-----

SECTION 01 91 00**GENERAL COMMISSIONING REQUIREMENTS****PART 1 - GENERAL****1.1 COMMISSIONING DESCRIPTION**

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

encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:

1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.
 2. Verify and document proper integrated performance of equipment and systems.
 3. Verify that Operations & Maintenance documentation is complete.
 4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
 5. Verify that the VA's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
 6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.

1.2 CONTRACTUAL RELATIONSHIPS

- A. For this construction project, the Department of Veterans Affairs contracts with a Contractor to provide construction services. The contracts are administered by the VA Contracting Officer and the Resident Engineer as the designated representative of the Contracting Officer. On this project, the authority to modify the contract in any way is strictly limited to the authority of the Contracting Officer.
- B. In this project, only two contract parties are recognized and communications on contractual issues are strictly limited to VA Resident Engineer and the Contractor. It is the practice of the VA to require that communications between other parties to the contracts (Subcontractors and Vendors) be conducted through the Resident Engineer and Contractor. It is also the practice of the VA that communications

between other parties of the project (Commissioning Agent and Architect/Engineer) be conducted through the Resident Engineer.

- C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc.) is essential to the success of the Commissioning effort.
- D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and Resident Engineer. Thus, the procedures outlined in this specification must be executed within the following limitations:
1. No communications (verbal or written) from the Commissioning Agent shall be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and the Contractor.
 2. Commissioning Issues identified by the Commissioning Agent will be delivered to the Resident Engineer and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the Commissioning Agent and as suggestions for resolution.
 3. In the event that any Commissioning Issues and suggested resolutions are deemed by the Resident Engineer to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or Resident Engineer will issue an official directive to this effect.
 4. All parties to the Commissioning Process shall be individually responsible for alerting the Resident Engineer of any issues that

they deem to constitute a potential contract change prior to acting on these issues.

5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or Resident Engineer, with appropriate technical guidance from the Architect/Engineer and/or Commissioning Agent.

1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 32.16.15 PROJECT SCHEDULES (SMALL PROJECTS - DESIGN/BID/BUILD)
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- D. Section 01 81 13 SUSTAINABLE CONSTRUCTION REQUIREMENTS
- E. Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- F. Section 33 08 00 COMMISSIONING OF SITE UTILITIES.

1.4 SUMMARY

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

D. The commissioning activities have been developed to support the Green Buildings Initiative's Green Globes rating program and to support delivery of project performance in accordance with the VA requirements developed for the project.

1.5 ACRONYMS

List of Acronyms	
Acronym	Meaning
A/E	Architect / Engineer Design Team
AHJ	Authority Having Jurisdiction
ASHRAE	Association Society for Heating Air Condition and Refrigeration Engineers
BOD	Basis of Design
BSC	Building Systems Commissioning
CCTV	Closed Circuit Television
CD	Construction Documents
CMMS	Computerized Maintenance Management System
CO	Contracting Officer (VA)
COR	Contracting Officer's Representative (see also VA-RE)
COBie	Construction Operations Building Information Exchange
CPC	Construction Phase Commissioning
Cx	Commissioning
CxA	Commissioning Agent
CxM	Commissioning Manager
CxR	Commissioning Representative
DPC	Design Phase Commissioning
FPT	Functional Performance Test
GBI-GG	Green Building Initiative - Green Globes
HVAC	Heating, Ventilation, and Air Conditioning
LEED	Leadership in Energy and Environmental Design
NC	Department of Veterans Affairs National Cemetery
NCA	Department of Veterans Affairs National Cemetery Administration
NEBB	National Environmental Balancing Bureau
O&M	Operations & Maintenance
OPR	Owner's Project Requirements

List of Acronyms	
Acronym	Meaning
PFC	Pre-Functional Checklist
PFT	Pre-Functional Test
SD	Schematic Design
SO	Site Observation
TAB	Test Adjust and Balance
VA	Department of Veterans Affairs
VAMC	VA Medical Center
VA CFM	VA Office of Construction and Facilities Management
VACO	VA Central Office
VA PM	VA Project Manager
VA-RE	VA Resident Engineer
USGBC	United States Green Building Council

1.6 DEFINITIONS

Acceptance Phase Commissioning: Commissioning tasks executed after most construction has been completed, most Site Observations and Static Tests have been completed and Pre-Functional Testing has been completed and accepted. The main commissioning activities performed during this phase are verification that the installed systems are functional by conducting Systems Functional Performance tests and Owner Training.

Accuracy: The capability of an instrument to indicate the true value of a measured quantity.

Back Check: A back check is a verification that an agreed upon solution to a design comment has been adequately addressed in a subsequent design review

Basis of Design (BOD): The Engineer's Basis of Design is comprised of two components: the Design Criteria and the Design Narrative, these documents record the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines.

Benchmarks: Benchmarks are the comparison of a building's energy usage to other similar buildings and to the building itself. For example, ENERGY STAR Portfolio Manager is a frequently used and nationally recognized building energy benchmarking tool.

Building Information Modeling (BIM): Building Information Modeling is a parametric database which allows a building to be designed and constructed virtually in 3D, and provides reports both in 2D views and as schedules. This electronic information can be extracted and reused for pre-populating facility management CMMS systems. Building Systems Commissioning (BSC): NEBB acronym used to designate its commissioning program.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

CCTV: Closed circuit Television. Normally used for security surveillance and alarm detections as part of a special electrical security system.

COBie: Construction Operations Building Information Exchange (COBie) is an electronic industry data format used to transfer information developed during design, construction, and commissioning into the Computer Maintenance Management Systems (CMMS) used to operate facilities. See the Whole Building Design Guide website for further information (<http://www.wbdg.org/resources/cobie.php>)

Commissionability: Defines a design component or construction process that has the necessary elements that will allow a system or component to be effectively measured, tested, operated and commissioned

Commissioning Agent (CxA): The qualified Commissioning Professional who administers the Cx process by managing the Cx team and overseeing the Commissioning Process. Where CxA is used in this specification it means the Commissioning Agent, members of his staff or appointed members of the commissioning team. Note that LEED uses the term Commissioning Authority in lieu of Commissioning Agent.

Commissioning Checklists: Lists of data or inspections to be verified to ensure proper system or component installation, operation, and function. Verification checklists are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements (OPR) is being achieved.

Commissioning Design Review: The commissioning design review is a collaborative review of the design professionals design documents for items pertaining to the following: owner's project requirements; basis

of design; operability and maintainability (O&M) including documentation; functionality; training; energy efficiency, control systems' sequence of operations including building automation system features; commissioning specifications and the ability to functionally test the systems.

Commissioning Issue: A condition identified by the Commissioning Agent or other member of the Commissioning Team that adversely affects the commissionability, operability, maintainability, or functionality of a system, equipment, or component. A condition that is in conflict with the Contract Documents and/or performance requirements of the installed systems and components. (See also - Commissioning Observation).

Commissioning Manager (CxM): A qualified individual appointed by the Contractor to manage the commissioning process on behalf of the Contractor.

Commissioning Observation: An issue identified by the Commissioning Agent or other member of the Commissioning Team that does not conform to the project OPR, contract documents or standard industry best practices. (See also Commissioning Issue)

Commissioning Plan: A document that outlines the commissioning process, commissioning scope and defines responsibilities, processes, schedules, and the documentation requirements of the Commissioning Process.

Commissioning Process: A quality focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems, components, and assemblies are planned, designed, installed, tested, can be operated, and maintained to meet the Owner's Project Requirements.

Commissioning Report: The final commissioning document which presents the commissioning process results for the project. Cx reports include an executive summary, the commissioning plan, issue log, correspondence, and all appropriate check sheets and test forms.

Commissioning Representative (CxR): An individual appointed by a sub-contractor to manage the commissioning process on behalf of the sub-contractor.

Commissioning Specifications: The contract documents that detail the objective, scope and implementation of the commissioning process as developed in the Commissioning Plan.

Commissioning Team: Individual team members whose coordinated actions are responsible for implementing the Commissioning Process.

Construction Phase Commissioning: All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Contract Documents (CD): Contract documents include design and construction contracts, price agreements and procedure agreements. Contract Documents also include all final and complete drawings, specifications and all applicable contract modifications or supplements.

Construction Phase Commissioning (CPC): All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Coordination Drawings: Drawings showing the work of all trades that are used to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances. On mechanical projects, coordination drawings include structural steel, ductwork, major piping and electrical conduit and show the elevations and locations of the above components.

Data Logging: The monitoring and recording of temperature, flow, current, status, pressure, etc. of equipment using stand-alone data recorders.

Deferred System Test: Tests that cannot be completed at the end of the acceptance phase due to ambient conditions, schedule issues or other conditions preventing testing during the normal acceptance testing period.

Deficiency: See "Commissioning Issue".

Design Criteria: A listing of the VA Design Criteria outlining the project design requirements, including its source. These are used during the design process to show the design elements meet the OPR.

Design Intent: The overall term that includes the OPR and the BOD. It is a detailed explanation of the ideas, concepts, and criteria that are defined by the owner to be important. The design intent documents are

utilized to provide a written record of these ideas, concepts and criteria.

Design Narrative: A written description of the proposed design solutions that satisfy the requirements of the OPR.

Design Phase Commissioning (DPC): All commissioning tasks executed during the design phase of the project.

Environmental Systems: Systems that use a combination of mechanical equipment, airflow, water flow and electrical energy to provide heating, ventilating, air conditioning, humidification, and dehumidification for the purpose of human comfort or process control of temperature and humidity.

Executive Summary: A section of the Commissioning report that reviews the general outcome of the project. It also includes any unresolved issues, recommendations for the resolution of unresolved issues and all deferred testing requirements.

Functionality: This defines a design component or construction process which will allow a system or component to operate or be constructed in a manner that will produce the required outcome of the OPR.

Functional Test Procedure (FTP): A written protocol that defines methods, steps, personnel, and acceptance criteria for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Industry Accepted Best Practice: A design component or construction process that has achieved industry consensus for quality performance and functionality. Refer to the current edition of the NEBB Design Phase Commissioning Handbook for examples.

Installation Verification: Observations or inspections that confirm the system or component has been installed in accordance with the contract documents and to industry accepted best practices.

Integrated System Testing: Integrated Systems Testing procedures entail testing of multiple integrated systems performance to verify proper functional interface between systems. Typical Integrated Systems Testing includes verifying that building systems respond properly to loss of utility, transfer to emergency power sources, re-transfer from emergency power source to normal utility source; interface between HVAC controls and Fire Alarm systems for equipment shutdown, interface

between Fire Alarm system and elevator control systems for elevator recall and shutdown; interface between Fire Alarm System and Security Access Control Systems to control access to spaces during fire alarm conditions; and other similar tests as determined for each specific project.

Issues Log: A formal and ongoing record of problems or concerns - and their resolution - that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

Lessons Learned Workshop: A workshop conducted to discuss and document project successes and identify opportunities for improvements for future projects.

Maintainability: A design component or construction process that will allow a system or component to be effectively maintained. This includes adequate room for access to adjust and repair the equipment.

Maintainability also includes components that have readily obtainable repair parts or service.

Manual Test: Testing using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the 'observation').

Owner's Project Requirements (OPR): A written document that details the project requirements and the expectations of how the building and its systems will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

Peer Review: A formal in-depth review separate from the commissioning review processes. The level of effort and intensity is much greater than a typical commissioning facilitation or extended commissioning review. The VA usually hires an independent third-party (called the IDIQ A/E) to conduct peer reviews.

Precision: The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

Pre-Design Phase Commissioning: Commissioning tasks performed prior to the commencement of design activities that includes project programming and the development of the commissioning process for the project

Pre-Functional Checklist (PFC): A form used by the contractor to verify that appropriate components are onsite, correctly installed, set up, calibrated, functional and ready for functional testing.

Pre-Functional Test (PFT): An inspection or test that is done before functional testing. PFT's include installation verification and system and component start up tests.

Procedure or Protocol: A defined approach that outlines the execution of a sequence of work or operations. Procedures are used to produce repeatable and defined results.

Range: The upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

Resolution: This word has two meanings in the Cx Process. The first refers to the smallest change in a measured variable that an instrument can detect. The second refers to the implementation of actions that correct a tested or observed deficiency.

Site Observation Visit: On-site inspections and observations made by the Commissioning Agent for the purpose of verifying component, equipment, and system installation, to observe contractor testing, equipment start-up procedures, or other purposes.

Site Observation Reports (SO): Reports of site inspections and observations made by the Commissioning Agent. Observation reports are intended to provide early indication of an installation issue which will need correction or analysis.

Special System Inspections: Inspections required by a local code authority prior to occupancy and are not normally a part of the commissioning process.

Static Tests: Tests or inspections that validate a specified static condition such as pressure testing. Static tests may be specification or code initiated.

Start Up Tests: Tests that validate the component or system is ready for automatic operation in accordance with the manufactures requirements.

Systems Manual: A system-focused composite document that includes all information required for the owners operators to operate the systems.

Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Testing: The use of specialized and calibrated instruments to measure parameters such as: temperature, pressure, vapor flow, air flow, fluid flow, rotational speed, electrical characteristics, velocity, and other data in order to determine performance, operation, or function.

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.

Thermal Scans: Thermographic pictures taken with an Infrared Thermographic Camera. Thermographic pictures show the relative temperatures of objects and surfaces and are used to identify leaks, thermal bridging, thermal intrusion, electrical overload conditions, moisture containment, and insulation failure.

Training Plan: A written document that details, in outline form the expectations of the operator training. Training agendas should include instruction on how to obtain service, operate, startup, shutdown and maintain all systems and components of the project.

Trending: Monitoring over a period of time with the building automation system.

Unresolved Commissioning Issue: Any Commissioning Issue that, at the time that the Final Report or the Amended Final Report is issued that has not been either resolved by the construction team or accepted by the VA. **Validation:** The process by which work is verified as complete and operating correctly:

1. First party validation occurs when a firm or individual verifying the task is the same firm or individual performing the task.
2. Second party validation occurs when the firm or individual verifying the task is under the control of the firm performing the task or has other possibilities of financial conflicts of

interest in the resolution (Architects, Designers, General Contractors and Third Tier Subcontractors or Vendors).

3. Third party validation occurs when the firm verifying the task is not associated with or under control of the firm performing or designing the task.

Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner’s Project Requirements.

Warranty Phase Commissioning: Commissioning efforts executed after a project has been completed and accepted by the Owner. Warranty Phase Commissioning includes follow-up on verification of system performance, measurement and verification tasks and assistance in identifying warranty issues and enforcing warranty provisions of the construction contract.

Warranty Visit: A commissioning meeting and site review where all outstanding warranty issues and deferred testing is reviewed and discussed.

Whole Building Commissioning: Commissioning of building systems such as Building Envelope, HVAC, Electrical, Special Electrical (Fire Alarm, Security & Communications), Plumbing and Fire Protection as described in this specification.

1.7 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the VA’s Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.
- B. The following systems will be commissioned as part of this project:

Systems To Be Commissioned	
System	Description
Specialties	
Equipment	
Conveying Equipment	
Fire Suppression	

Systems To Be Commissioned	
System	Description
Plumbing	
HVAC	
Noise and Vibration Control	Noise and vibration levels for critical equipment such as Air Handlers, Chillers, Cooling Towers, Boilers, Generators, etc. will be commissioned as part of the system commissioning
Steam/Heating Hot Water System**	Boilers, boiler feed water system, economizers/heat recovery equipment, condensate recovery, water treatment, boiler fuel system, controls, interface with facility DDC system.
Facility Fuel Systems	Boiler fuel system, generator fuel system
Facility Fuel Gas Systems	Witness Natural gas piping pressure testing, natural gas compressors and storage, propane storage
Electrical	
Site Utilities	
Transportation	
Integrated Systems Tests	
Table Notes	

1.8 COMMISSIONING TEAM

- A. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, schedulers, suppliers, and specialists deemed appropriate by the Department of Veterans Affairs (VA) and Commissioning Agent.
- B. Members Appointed by Contractor:
1. Contractor' Commissioning Manager: The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team.

2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions.

C. Members Appointed by VA:

1. Commissioning Agent: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The VA will engage the CxA under a separate contract.
2. User: Representatives of the facility user and operation and maintenance personnel.
3. A/E: Representative of the Architect and engineering design professionals.

1.9 VA'S COMMISSIONING RESPONSIBILITIES

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

1.10 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. The Contractor shall assign a Commissioning Manager to manage commissioning activities of the Contractor, and subcontractors.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.

- C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
1. Participate in commissioning coordination meetings.
 2. Conduct operation and maintenance training sessions in accordance with approved training plans.
 3. Verify that Work is complete, and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
 5. Review and comment on commissioning documentation.
 6. Participate in meetings to coordinate Systems Functional Performance Testing.
 7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan.
 8. Provide information to the Commissioning Agent for developing commissioning plan.
 9. Participate in training sessions for VA's operation and maintenance personnel.
 10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

1.11 COMMISSIONING AGENT'S RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Prepare the commissioning plan. See Paragraph 1.11-A of this specification Section for further information.
- C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and

- comment on the ability to test and operate the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents.
- D. At the beginning of the construction phase, conduct an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.
 - E. Convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.
 - F. Observe construction and report progress, observations and issues. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
 - G. Prepare Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.
 - H. Coordinate Systems Functional Performance Testing schedule with the Contractor.
 - I. Witness selected systems startups.
 - J. Verify selected Pre-Functional Checklists completed and submitted by the Contractor.
 - K. Witness and document Systems Functional Performance Testing.
 - L. Compile test data, inspection reports, and certificates and include them in the systems manual and commissioning report.
 - M. Review and comment on operation and maintenance (O&M) documentation and systems manual outline for compliance with the Contract Documents. Operation and maintenance documentation requirements are specified in Paragraph 1.25, Section 01 00 00 GENERAL REQUIREMENTS.

- N. Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.
- O. Prepare commissioning Field Observation Reports.
- P. Prepare the Final Commissioning Report.
- Q. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal Systems Functional Performance Testing. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.
- R. Assemble the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

1.12 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by Commissioning Agent, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
 - 2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
 - 3. Identification of systems and equipment to be commissioned.
 - 4. Schedule of Commissioning Coordination meetings.
 - 5. Identification of items that must be completed before the next operation can proceed.

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

and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The Commissioning Agent will spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.

- D. Test and Inspection Reports: The Commissioning Agent will record test data, observations, and measurements on Systems Functional Performance Test Procedure. The report will also include recommendation for system acceptance or non-acceptance. Photographs, forms, and other means appropriate for the application shall be included with data. Commissioning Agent Will compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.
- E. Corrective Action Documents: The Commissioning Agent will document corrective action taken for systems and equipment that fail tests. The documentation will include any required modifications to systems and equipment and/or revisions to test procedures, if any. The Commissioning Agent will witness and document any retesting of systems and/or equipment requiring corrective action and document retest results.
- F. Commissioning Issues Log: The Commissioning Agent will prepare and maintain Commissioning Issues Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. These observations and issues include, but are not limited to, those that are at variance with the Contract Documents. The Commissioning Issues Log will identify and track issues as they are encountered, the party responsible for resolution, progress toward resolution, and document how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved issues.
 - 1. Creating a Commissioning Issues Log Entry:
 - a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
 - b. Assign a descriptive title for the issue.
 - c. Identify date and time of the issue.

- d. Identify test number of test being performed at the time of the observation, if applicable, for cross reference.
 - e. Identify system, subsystem, and equipment to which the issue applies.
 - f. Identify location of system, subsystem, and equipment.
 - g. Include information that may be helpful in diagnosing or evaluating the issue.
 - h. Note recommended corrective action.
 - i. Identify commissioning team member responsible for corrective action.
 - j. Identify expected date of correction.
 - k. Identify person that identified the issue.
2. Documenting Issue Resolution:
- a. Log date correction is completed, or the issue is resolved.
 - b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
 - c. Identify changes to the Contract Documents that may require action.
 - d. State that correction was completed, and system, subsystem, and equipment are ready for retest, if applicable.
 - e. Identify person(s) who corrected or resolved the issue.
 - f. Identify person(s) verifying the issue resolution.
- G. Final Commissioning Report: The Commissioning Agent will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the Department of Veterans Affairs when determining that systems will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during VA occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:

1. Lists and explanations of substitutions; compromises; variances with the Contract Documents; record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the Commissioning Agent.
 2. Commissioning plan.
 3. Pre-Functional Checklists completed by the Contractor, with annotation of the Commissioning Agent review and spot check.
 4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
 5. 5, Commissioning Issues Log.
 6. Listing of deferred and off-season test(s) not performed, including the schedule for their completion.
- H. Addendum to Final Commissioning Report: The Commissioning Agent will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The Addendum will indicate whether systems, subsystems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:
1. Documentation of deferred and off-season test(s) results.
 2. Completed Systems Functional Performance Test Procedures for off season test(s).
 3. Documentation that unresolved system performance issues have been resolved.
 4. Updated Commissioning Issues Log, including status of unresolved issues.
 5. Identification of potential Warranty Claims to be corrected by the Contractor.
- I. Systems Manual: The Commissioning Agent will gather required information and compile the Systems Manual. The Systems Manual will include, but is not limited to, the following:
1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.
 2. Reference to Final Commissioning Plan.
 3. Reference to Final Commissioning Report.

4. Approved Operation and Maintenance Data as submitted by the Contractor.

1.13 SUBMITTALS

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

level of testing rigor, and the level of Contractor support required during performance of system's testing.

- B. Final Commissioning Plan Submittal: Based on the Final Construction Documents and the Contractor's project team, the Commissioning Agent will prepare the Final Commissioning Plan as described in this section. The Commissioning Agent will submit three hard copies and three sets of electronic files of Final Commissioning Plan. The Contractor shall review the Commissioning Plan and provide any comments to the VA. The Commissioning Agent will incorporate review comments into the Final Commissioning Plan as directed by the VA.
- C. Systems Functional Performance Test Procedure: The Commissioning Agent will submit preliminary Systems Functional Performance Test Procedures to the Contractor, and the VA for review and comment. The Contractor shall return review comments to the VA and the Commissioning Agent. The VA will also return review comments to the Commissioning Agent. The Commissioning Agent will incorporate review comments into the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing.
- D. Pre-Functional Checklists: The Commissioning Agent will submit Pre-Functional Checklists to be completed by the Contractor.
- E. Test and Inspection Reports: The Commissioning Agent will submit test and inspection reports to the VA with copies to the Contractor and the Architect/Engineer.
- F. Corrective Action Documents: The Commissioning Agent will submit corrective action documents to the VA Resident Engineer with copies to the Contractor and Architect.
- G. Preliminary Commissioning Report Submittal: The Commissioning Agent will submit three electronic copies of the preliminary commissioning report. One electronic copy, with review comments, will be returned to the Commissioning Agent for preparation of the final submittal.
- H. Final Commissioning Report Submittal: The Commissioning Agent will submit four sets of electronically formatted information of the final commissioning report to the VA. The final submittal will incorporate comments as directed by the VA.
- I. Data for Commissioning:

1. The Commissioning Agent will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
2. The Commissioning Agent may request further documentation as is necessary for the commissioning process or to support other VA data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

1.14 COMMISSIONING PROCESS

- A. The Commissioning Agent will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with the VA and the Contractor. As directed by the VA, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.
- B. Within 30 days of contract award, the Contractor shall designate a specific individual as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor.
- C. Within 45 days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CXR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

1.15 QUALITY ASSURANCE

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

1.16 COORDINATION

- A. Management: The Commissioning Agent will coordinate the commissioning activities with the VA and Contractor. The Commissioning Agent will submit commissioning documents and information to the VA. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor shall work with the Commissioning Agent and the VA to incorporate the commissioning activities into the construction schedule. The Commissioning Agent will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor and the VA to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction as directed by the VA.
- C. Initial Schedule of Commissioning Events: The Commissioning Agent will provide the initial schedule of primary commissioning events in the Commissioning Plan and at the commissioning coordination meetings. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the Commissioning Agent.
- D. Commissioning Coordinating Meetings: The Commissioning Agent will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to

discuss scheduling conflicts, and to discuss upcoming commissioning process activities.

- E. Pretesting Meetings: The Commissioning Agent will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.
- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

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

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES

A. The following table outlines the roles and responsibilities for the Commissioning Team members during the Construction Phase:

Construction Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Meetings	Construction Commissioning Kick Off meeting	L	A	P	P	O	
	Commissioning Meetings	L	A	P	P	O	
	Project Progress Meetings	P	A	P	L	O	
	Controls Meeting	L	A	P	P	O	
Coordination	Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD.	L	A	P	P	N/A	
Cx Plan & Spec	Final Commissioning Plan	L	A	R	R	O	
Schedules	Duration Schedule for Commissioning Activities	L	A	R	R	N/A	
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	O	
	Maintain BOD/DID on behalf of Owner	L	A	R	R	O	

Construction Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Document Reviews	TAB Plan Review	L	A	R	R	O	
	Submittal and Shop Drawing Review	R	A	R	L	O	
	Review Contractor Equipment Startup Checklists	L	A	R	R	N/A	
	Review Change Orders, ASI, and RFI	L	A	R	R	N/A	
Site Observations	Witness Factory Testing	P	A	P	L	O	
	Construction Observation Site Visits	L	A	R	R	O	
Functional Test Protocols	Final Pre-Functional Checklists	L	A	R	R	O	
	Final Functional Performance Test Protocols	L	A	R	R	O	
Technical Activities	Issues Resolution Meetings	P	A	P	L	O	
Reports and Logs	Status Reports	L	A	R	R	O	
	Maintain Commissioning Issues Log	L	A	R	R	O	

B. The following table outlines the roles and responsibilities for the Commissioning Team members during the Acceptance Phase:

Acceptance Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Meetings	Commissioning Meetings	L	A	P	P	O	
	Project Progress Meetings	P	A	P	L	O	
	Pre-Test Coordination Meeting	L	A	P	P	O	
	Lessons Learned and Commissioning Report Review Meeting	L	A	P	P	O	
Coordination	Coordinate with [OGC's, AHJ, Vendors, etc.] to ensure that CxA interacts properly with other systems as needed to support OPR and BOD	L	P	P	P	O	
Cx Plan & Spec	Maintain/Update Commissioning Plan	L	A	R	R	O	
Schedules	Prepare Functional Test Schedule	L	A	R	R	O	
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	O	
	Maintain BOD/DID on behalf of Owner	L	A	R	R	O	
Document Reviews	Review Completed Pre-Functional Checklists	L	A	R	R	O	
	Pre-Functional Checklist Verification	L	A	R	R	O	

Acceptance Phase		CxA = Commissioning Agent RE = Resident Engineer A/E = Design Arch/Engineer PC = Prime Contractor O&M = Gov't Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
	Review Operations & Maintenance Manuals	L	A	R	R	R	
	Training Plan Review	L	A	R	R	R	
	Warranty Review	L	A	R	R	O	
	Review TAB Report	L	A	R	R	O	
Site Observations	Construction Observation Site Visits	L	A	R	R	O	
	Witness Selected Equipment Startup	L	A	R	R	O	
Functional Test Protocols	TAB Verification	L	A	R	R	O	
	Systems Functional Performance Testing	L	A	P	P	P	
	Retesting	L	A	P	P	P	
Technical Activities	Issues Resolution Meetings	P	A	P	L	O	
	Systems Training	L	S	R	P	P	
Reports and Logs	Status Reports	L	A	R	R	O	
	Maintain Commissioning Issues Log	L	A	R	R	O	
	Final Commissioning Report	L	A	R	R	R	
	Prepare Systems Manuals	L	A	R	R	R	

C. The following table outlines the roles and responsibilities for the Commissioning Team members during the Warranty Phase:

Warranty Phase		CxA = Commissioning Agent					L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer					P = Participate
		A/E = Design Arch/Engineer					A = Approve
		PC = Prime Contractor					R = Review
		O&M = Gov't Facility O&M					O = Optional
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
Meetings	Post-Occupancy User Review Meeting	L	A	O	P	P	
Site Observations	Periodic Site Visits	L	A	O	O	P	
Functional Test Protocols	Deferred and/or seasonal Testing	L	A	O	P	P	
Technical Activities	Issues Resolution Meetings	L	S	O	O	P	

Warranty Phase		CxA = Commissioning Agent					L = Lead
Commissioning Roles & Responsibilities		RE = Resident Engineer					P = Participate
		A/E = Design Arch/Engineer					A = Approve
		PC = Prime Contractor					R = Review
		O&M = Gov't Facility O&M					O = Optional
Category	Task Description	CxA	RE	A/E	PC	O&M	Notes
	Post-Occupancy Warranty Checkup and review of Significant Outstanding Issues	L	A		R	P	
Reports and Logs	Final Commissioning Report Amendment	L	A		R	R	
	Status Reports	L	A		R	R	

3.2 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS

A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.

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

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

3.3 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP

- A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the VA and the Commissioning Agent within two days of completion.
- B. The Commissioning Agent will review the report and submit comments to the VA. The Commissioning Agent will work with the Contractor to correct and verify deficiencies or uncompleted items. The Commissioning Agent will involve the VA and others as necessary. The Contractor shall

correct all areas that are noncompliant or incomplete in the checklists in a timely manner and shall notify the VA and Commissioning Agent as soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the Commissioning Agent will recommend approval of the checklists and startup of each system to the VA.

- C. The Contractor shall be responsible for resolution of deficiencies as directed the VA.

3.4 PHASED COMMISSIONING

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

3.5 DDC SYSTEM TRENDING FOR COMMISSIONING

- A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems at intervals specified below.
- B. Alarms are a means to notify the system operator that abnormal conditions are present in the system. Alarms shall be structured into three tiers - Critical, Priority, and Maintenance.
 1. Critical alarms are intended to be alarms that require the immediate attention of and action by the Operator. These alarms shall be displayed on the Operator Workstation in a popup style window that is graphically linked to the associated unit's graphical display. The popup style window shall be displayed on top of any active window within the screen, including non DDC system software.
 2. Priority level alarms are to be printed to a printer which is connected to the Operator's Workstation located within the engineer's office. Additionally, Priority level alarms shall be able to be monitored and viewed through an active alarm application. Priority level alarms are alarms which shall require reaction from the operator or maintenance personnel within a normal work shift, and not immediate action.
 3. Maintenance alarms are intended to be minor issues which would require examination by maintenance personnel within the following shift. These alarms shall be generated in a scheduled report

automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.

- C. The Contractor shall provide a wireless internet network in the building for use during controls programming, checkout, and commissioning. This network will allow project team members to more effectively program, view, manipulate and test control devices while being in the same room as the controlled device.
- D. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below and included with the Systems Functional Performance Test Procedures. Trending shall occur before, during and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the Resident Engineer and Commissioning Agent for review and analysis before, during dynamic operation, and after Systems Functional Performance Testing. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:
1. Pre-testing, Testing, and Post-testing - Trend reports of trend logs and graphical trend plots are required as defined by the Commissioning Agent. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the Resident Engineer. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the Resident Engineer, prior to the execution of Systems Functional Performance Testing.
 2. Dynamic plotting - The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.

3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System, then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.
4. The following tables indicate the points to be trended and alarmed by system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV = Change of Value. The Alarm Type indicates the alarm priority; C = Critical, P = Priority, and M = Maintenance. The Alarm Range column indicates when the point is considered in the alarm state. The Alarm Delay column indicates the length of time the point must remain in an alarm state before the alarm is recorded in the DDC. The intent is to allow minor, short-duration events to be corrected by the DDC system prior to recording an alarm.

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 1 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 2 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 2 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 3 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 3 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 3 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
System Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 1 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 1 on Propane	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 2 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2 on Propane	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 3 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 3 on Propane	DI	COV	12 Hours	3 days	N/A		
Boiler 3 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 3 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 3 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Combustion Damper Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Condensate Recovery Pump Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Boiler 1 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		
Boiler 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Boiler 3 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Combustion Damper Command	DO	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

E. The Contractor shall provide the following information prior to Systems Functional Performance Testing. Any documentation that is modified after submission shall be recorded and resubmitted to the Resident Engineer and Commissioning Agent.

1. Point-to-Point checkout documentation.

2. Sensor field calibration documentation including system name, sensor/point name, measured value, DDC value, and Correction Factor.
3. A sensor calibration table listing the referencing the location of procedures to following in the O&M manuals, and the frequency at which calibration should be performed for all sensors, separated by system, subsystem, and type. The calibration requirements shall be submitted both in the O&M manuals and separately in a standalone document containing all sensors for inclusion in the commissioning documentation. The following table is a sample that can be used as a template for submission.

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

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

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

3.6 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion

to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

- C. Development of Systems Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the Commissioning Agent will develop specific Systems Functional Test Procedures to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the Commissioning Agent in developing the Systems Functional Performance Test procedures as requested by the Commissioning Agent i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the Commissioning Agent will provide a copy of the Systems Functional Performance Test procedures to the VA, the Architect/Engineer, and the Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.
- D. Purpose of Test Procedures: The purpose of each specific Systems Functional Performance Test is to verify and document compliance with the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.) The test procedure forms developed by the Commissioning Agent will include, but not be limited to, the following information:
1. System and equipment or component name(s)
 2. Equipment location and ID number

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

- e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
 4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
 5. Indirect Indicators: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout.
- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.
- G. Sampling: No sampling is allowed in completing Pre-Functional Checklists. Sampling is allowed for Systems Functional Performance Test Procedures execution. The Commissioning Agent will determine the sampling rate. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Agent may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to

continuing with Systems Functional Performance Testing of the remaining units.

- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days' notice to the Commissioning Agent and the VA regarding the completion schedule for the Pre-Functional Checklists and startup of all equipment and systems. The Commissioning Agent will schedule Systems Functional Performance Tests with the Contractor and VA. The Commissioning Agent will witness and document the Systems Functional Performance Testing of systems. The Contractor shall execute the tests in accordance with the Systems Functional Performance Test Procedure.
- J. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The control system shall be sufficiently tested and approved by the Commissioning Agent and the VA before it is used to verify performance of other components or systems. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems will be checked.
- K. Problem Solving: The Commissioning Agent will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

3.7 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The Commissioning Agent will witness and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the Commissioning Agent for that purpose. Prior to testing, the Commissioning Agent will provide these forms to the VA and the Contractor for review and approval. The Contractor shall include the filled-out forms with the O&M manual data.

- B. Nonconformance: The Commissioning Agent will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the VA on Commissioning Field Reports and/or the Commissioning Master Issues Log.
1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.
 2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Agent shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so by direction from the VA.
 3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the Commissioning Agent shall discuss the issue with the Contractor and the VA.
 4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
 - a. The Commissioning Agent will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the Commissioning Agent will submit a Commissioning Field Report to the VA. The Commissioning Agent will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the VA and the Commissioning Agent.
 - b. The need for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test and the test shall be repeated.
 5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
 - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with

the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.

- b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with the Department of Veterans Affairs.
 - c. The Commissioning Agent will document the resolution process.
 - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the Commissioning Agent. The requirement for retesting will be determined by the Commissioning Agent. If retesting is required, the Commissioning Agent and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.
- C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the VA. In such case, the Contractor shall provide the VA with the following:
1. Within one week of notification from the VA, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
 2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.

3. The VA shall determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution shall be installed by the Contractor and the VA shall be allowed to test the installations for up to one week, upon which the VA will decide whether to accept the solution.
 5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
- E. Approval: The Commissioning Agent will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the Commissioning Agent and by the VA. The Commissioning Agent will evaluate each test and report to the VA using a standard form. The VA will give final approval on each test using the same form and provide signed copies to the Commissioning Agent and the Contractor.

3.8 DEFERRED TESTING

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

Deferred Seasonal Systems Functional Performance Tests shall be executed by the Contractor in accordance with these specifications.

3.9 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

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

3. Attendance Record: For each training module, submit list of participants and length of instruction time.
 4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
 5. Demonstration and Training Recording:
 - a. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training module, record each chart containing learning objective and lesson outline.
 - b. Video Format: Provide high quality color DVD color on standard size DVD disks.
 - c. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
 - d. Narration: Describe scenes on video recording by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - e. Submit two copies within seven days of end of each training module.
 6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.
- D. Quality Assurance:
1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
 2. Instructor Qualifications: A factory authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

E. Training Coordination:

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

F. Instruction Program:

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - a. Fire protection systems, including fire alarm, fire pumps, and fire suppression systems.
 - b. Intrusion detection systems.
 - c. Conveying systems, including elevators, wheelchair lifts, escalators, and automated materials handling systems.
 - d. Medical equipment, including medical gas equipment and piping.
 - e. Laboratory equipment, including laboratory air and vacuum equipment and piping.
 - f. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
 - g. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
 - h. HVAC systems, including air handling equipment, air distribution systems, and terminal equipment and devices.
 - i. HVAC instrumentation and controls.
 - j. Electrical service and distribution, including switchgear, transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
 - k. Packaged engine generators, including synchronizing switchgear/switchboards, and transfer switches.
 - l. Lighting equipment and controls.

- m. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass evacuation, voice and data, and entertainment television equipment.
 - n. Site utilities including lift stations, condensate pumping and return systems, and storm water pumping systems.
- G. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:
- 1. Basis of System Design, Operational Requirements, and Criteria:
Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. H, Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project Record Documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.

- f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
 5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
 6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
 7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
 8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.

e. Review of spare parts needed for operation and maintenance.

H. Training Execution:

1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
2. Instruction:
 - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Department of Veterans Affairs for number of participants, instruction times, and location.
 - b. Instructor: Engage qualified instructors to instruct VA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1) The Commissioning Agent will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2) The VA will furnish an instructor to describe VA's operational philosophy.
 - 3) The VA will furnish the Contractor with names and positions of participants.
3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the VA and the Commissioning Agent with at least seven days' advance notice.
4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, or a written, performance-based test.
5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

I. Demonstration and Training Recording:

1. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of

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

----- END -----

SECTION 02 21 13
SITE SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Researching and collecting documents informing surveys.
2. Performing boundary survey, topographic survey, and utility survey.
3. Creating survey drawings.

1.2 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Land Title Association and American Congress on Surveying and Mapping (ALTA-ACSM):

1. Accuracy Standards for ALTA-ACSM Land Title Surveys.

C. Federal Geographic Data Committee (FGDC):

1. STD-007.03-98 - Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy.
2. STD-007.04-02 - Geospatial Positioning Accuracy Standards Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management.

1.3 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Survey Drawings:

1. Prints: Two sets of black line, full size prints of each drawing.
2. Electronic Files: Consistent with computer-aided design (CAD) Standards described at www.cfm.va.gov/til/projReq.asp.

1.4 QUALITY ASSURANCE

A. Land Surveyor: One of the following:

1. Experienced professional land surveyor licensed in state in which project is located.
2. Experienced professional civil engineer licensed in state in which project is located and authorized to practice land surveying as civil engineer.

1.5 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 ACCESSORIES

- A. Monuments: Iron pin, with driven 16 mm (5/8 inch) diameter, minimum 600 mm (24 inches) long to prevent displacement.
- B. Stakes: Hardwood.
- C. Flagging: Plastic, roll form, highly visible, solid color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Research public and VA facility records for deeds, maps, monuments, plats, surveys, title certificates or abstracts, rights-of-way, easements, section line, other boundary line locations, and other documents pertaining to project site.
- B. Research public and VA facility utility records for aerial, surface, and subgrade structures and utility service lines and easements.

3.2 PREPARATION

- A. Coordinate with Contracting Officer's Representative for site access.
- B. Coordinate with adjacent property owners when access to adjoining properties is required.
 - 1. Notify Contracting Officer's Representative when access is denied.

3.3 SURVEYS

- A. Perform survey on ground according to Accuracy Standards for ALTA-ACSM Land Title Surveys.
- B. Boundary Survey:
 - 1. Locate permanent monuments within and along survey boundary.
 - 2. Set permanent monument at property corners when monument is not found.
 - 3. Temporarily mark monument locations with stake and flagging.
 - 4. Reconcile differences between legal description and survey.
- C. Topographic Survey:
 - 1. Vertical Control: National Geodetic Survey or existing VA Medical Center benchmark.

2. Establish minimum three permanent benchmarks plus one permanent benchmark for each 1.6 hectares (4 acres) within survey boundary.
 3. Determine project site contours at maximum 300 mm (1 foot) interval.
 4. Determine spot elevations at specified locations.
- D. Utility Survey:
1. Locate piped utilities and utility structures. Identify service type, sizes, depths, and pressures.
 2. Locate fire hydrants.
 3. Locate wired utilities and utility structures. Identify service type, rated capacities, and elevations above and below grade.
 4. Identify each utility authority including contact person and phone number.
- E. Locate permanent structures within survey boundary by perpendicular dimension to property lines.
1. Determine structure plan dimensions, heights, and vertical offsets.
 2. Determine projections and overhangs beyond structure perimeter at grade.
 3. Determine number of stories and primary building materials.
- F. Locate rights-of-way and easements within and adjacent to survey boundary by perpendicular dimension to property line.
1. Locate project site access from rights-of-way by dimension from survey monument. Determine site access width.

3.4 SURVEY DRAWING REQUIREMENTS

- A. Consult Contracting Officer's Representative to confirm required survey scale and drawing size.
1. Drawing Size: Maximum 760 by 1070 mm (30 by 42 inches).
 2. Boundary Survey Scale: Maximum 1 to 35 (1 inch equals 30 feet).
 3. Enlarged Detail Areas: Scale as required to present dimensional data and survey information clearly. Maintain orientation aligned with smaller scale view.
 4. Plan Orientation: North at top of drawing sheet.
- B. Drawing Notations:
1. Land Surveyor: Name, address, telephone number, signature, seal, and registration number.
 2. Survey Dates: Date survey was initially completed and subsequent revision dates.

3. Certification: Certify each drawing adjacent to land surveyor's seal:
 - a. "I hereby certify that all information indicated on this drawing was obtained or verified by actual measurements in the field and that every effort has been made to provide complete and accurate information."
 - b. Title, number, and total number of drawings on each drawing.
 - c. Scale in metric and imperial measurement.
 - d. Graphic scale in metric and imperial measurement.
 - e. Graphic symbol and abbreviation legends.
 - f. North arrow for plan view drawings.
 - g. Benchmark locations.
 - h. Horizontal and vertical control datum.
 - i. Adjacent property owner names.
 - j. Zoning classifications.
 - k. Building street numbers.
 4. Evidence of Possession: Indicate character and location of evidence of possession affecting project site. Notation absence signifies no observable evidence of possession.
- C. Vicinity Map: Indicate project site and nearby roadways and intersections.
- D. Record Documents Forming Survey Basis: Indicate titles, source, and recording data of documents relied upon to complete survey.
- E. Legal Description: Recorded title boundaries.
- F. Land Area: Report in hectares (acres) as defined by the boundaries of the legal description of the surveyed premises, including legal description of the land.
1. Accuracy: 0.005 hectares (0.001 acres).
- G. Boundary Lines: Show point of beginning, length and bearing for straight lines, and angle, radius, point of curvature, point of tangency, and length of curved lines.
1. Include bearing basis and data necessary to mathematically close survey.
 2. When recorded and measured bearings, angles, and distances differ, indicate both recorded and measured data.

- a. Indicate when recorded description does not mathematically close survey.
 3. Indicate found and installed monuments establishing basis of survey.
 4. Contiguity, Gores, and Overlaps: Identify discrepancies within and along survey boundary.
- H. Lots and Parcels: Indicate entire lots and parcels included within and intersected by survey boundary.
- I. Roadways: Indicate names and widths of rights-of-way and roadways within and abutting survey boundary.
1. Indicate changes in rights-of-way lines either completed or proposed.
 2. Indicate accesses to roadways.
 3. Indicate abandoned roadways.
 4. Indicated unopened dedicated roadways.
- J. Setbacks: Indicate recorded setback and building restriction lines.
- K. Structures and Site Improvements: Indicate buildings, walls, fences, signs, and other visible improvements.
1. Indicate each building dimensioned to property lines and other structures.
 2. Indicate exterior dimensions of buildings at ground level. Show area of building footprint and gross floor area of entire building.
 3. Indicate maximum measured height of buildings above grade, point of measurement, and number of stories.
 4. Indicate spot elevations at building entrances, first floor, service docks, corners, steps, ramps, and grade slabs.
 5. Indicate structures and site improvements within 1500 mm (5 feet) of survey boundary.
 6. Indicate encroachments on project site, adjoining property, easements, rights-of-way, and setback lines from fire escapes, bay windows, windows and doors opening out, flue pipes, stoops, eaves, cornices, areaways, stoops, other building projections, and site improvements.
 7. Identify setback, height, and floor space area restrictions set by applicable zoning and building codes and recorded subdivision maps. Indicate if no restrictions exist.
- L. Easements:

1. Indicate easements evidenced by recorded documents.
 - a. Indicate when easements cannot be located.
 2. Indicate observable easements created by roadways, rights-of-ways, water courses, drains, telephone, telegraph, electric and other wiring, water, sewer, oil, gas, and other pipelines within project site and on adjoining properties when potentially affecting project site.
 3. Indicate observable surface improvements of underground easements.
- M. Pavements and Railroad Tracks:
1. Indicate location, alignment, and dimensions for vehicular and pedestrian pavements and railroad tracks.
 2. Indicate pavement encroachments from adjacent properties onto project site and onto adjacent properties from project site.
 - a. Dimension encroachments from survey boundary.
 3. Indicate roadway and railroad tracks centerlines with true bearings and lengths by 15 m (50 feet) stationing.
 - a. Describe curves by designating points of curvature and tangency. Include curve data and location of radius and vertex points.
 - b. Indicate elevations at station points along roadway centerlines, roadway edges, and top and bottom of curbs.
 4. Indicate parking areas, parking striping, and total parking spaces.
 - a. Identify accessible parking spaces.
 5. Indicate curb cuts, driveways, and other accesses to public ways.
- N. Indicate cemetery and burial ground boundaries.
- O. Waterways:
1. Indicate boundaries of ponds, lakes, springs, and rivers bordering on or running through project site. Note date of measurement and that boundary is subject to change due to natural causes.
 2. Indicate flood plain location and elevation.
 3. Indicate watershed extent affecting project site.
- P. Indicate topographic contours.
- Q. Flood Zone: Indicate applicable flood zone from Federal Flood Insurance Rate Maps, by scaled map location and graphic plotting.
- R. Public and Private Utilities:
1. Indicate information source and operating authority for each utility.

2. Indicate utilities existing on or serving project site.
3. Indicate fire hydrants on project site and within 150 m (500 feet) of survey boundary.
4. Indicate manholes, catch basins, inlets, vaults, and other surface indications of subgrade services.
5. Indicate depths or invert elevations, sizes, materials, and pressures of utility pipes.
6. Indicate wires and cables serving, crossing, and adjacent to project site.
7. Indicate exterior lighting, traffic control facilities, security, and communications systems.
8. Indicate utility poles on project site and within 3 m (10 feet) of survey boundary.
9. Indicate dimensions of cross-wires or overhangs affecting project site.

S. Observable Evidence:

1. Indicate in-progress and recently completed earth moving work, building construction, and building additions.
2. Indicate in-progress and recently completed pavement construction and repairs.
3. Indicate areas used as solid waste dump, sump, and sanitary landfill.

T. Trees:

1. Indicate individual trees with minimum 150 mm (6 inches) diameter measured at 400 mm (48 inches) above grade.
2. Indicate wooded area perimeter outline and description of predominant vegetation.

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SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION:

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

1.2 RELATED WORK:

- A. Demolition and removal of roads, walks, curbs, and on-grade slabs outside buildings to be demolished: Section 31 20 00, EARTH MOVING.
- B. Safety Requirements: Section 01 35 26 Safety Requirements Article, ACCIDENT PREVENTION PLAN (APP).
- C. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Reserved items that are to remain the property of the Government: Section 01 00 00, GENERAL REQUIREMENTS.
- E. Asbestos Removal: Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- F. Lead Paint: Section 02 83 33.13, LEAD-BASED PAINT REMOVAL AND DISPOSAL.
- G. Environmental Protection: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- H. Construction Waste Management: Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT.
- I. Infectious Control: Section 01 35 26, SAFETY REQUIREMENTS.

1.3 PROTECTION:

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

- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.
- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to: ice, flooding, or pollution. Vacuum and dust the work area daily.
- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
 - a. No wall or part of wall shall be permitted to fall outwardly from structures.
 - b. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
 - c. 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.
 - d. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Medical Center; any damaged items shall be repaired or replaced as approved by the 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.

- H. The work shall comply with the requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- I. The work shall comply with the requirements of Section 01 00 00, GENERAL REQUIREMENTS and Section 01 35 26, SAFETY REQUIREMENTS.

1.4 UTILITY SERVICES:

- A. Demolish and remove outside utility service lines shown to be removed.
- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DEMOLITION:

- A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
 - a. As required for installation of new utility service lines.
 - b. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.
- B. Debris, including brick, concrete, stone, metals and similar materials shall become property of Contractor and shall be disposed of by him daily, off the Medical Center to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the COR. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state or local permits, rules and/or regulations.
- C. In removing buildings and structures of more than two stories, demolish work story by story starting at highest level and progressing down to third floor level. Demolition of first and second stories may proceed simultaneously.

- D. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- E. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by theCOR. When Utility lines are encountered that are not indicated on the drawings, the COR shall be notified prior to further work in that area.

3.2 CLEAN-UP:

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

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SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL**1.1 DESCRIPTION:**

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

1.2 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Concrete roads, walks, and similar exterior site work: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN:

- A. Testing agency for the trial concrete mix design retained and reimbursed by the Contractor and approved by Resident Engineer. For all other testing, refer to Section 01 45 29 Testing Laboratory Services.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology. Accompany request for approval of testing agency with a copy of Report of Latest Inspection of Laboratory Facilities by CCRL.
- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

1.4 TOLERANCES:

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).
- B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than 3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.
- C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and - 6 mm (-1/4 inch). Tolerance of thickness of beams more than 300 mm (12 inch) but less than 900 mm (3 feet) is +20 mm (+3/4 inch) and -10 mm (-3/8 inch).

- D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155, except as follows:
1. Test entire slab surface, including those areas within 600 mm (2 feet) of construction joints and vertical elements that project through slab surface.
 2. Maximum elevation change which may occur within 600 mm (2 feet) of any column or wall element is 6 mm (0.25 inches).
 3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 1500 mm (5 feet).

1.5 REGULATORY REQUIREMENTS:

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

1.6 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings: Reinforcing steel: Complete shop drawings
- C. Mill Test Reports:
 1. Reinforcing Steel.
 2. Cement.
- D. Manufacturer's Certificates:
 1. Abrasive aggregate.
 2. Lightweight aggregate for structural concrete.
 3. Air-entraining admixture.
 4. Chemical admixtures, including chloride ion content.
 5. Waterproof paper for curing concrete.
 6. Liquid membrane-forming compounds for curing concrete.
 7. Non-shrinking grout.
 8. Liquid hardener.
 9. Water stops.
 10. Expansion joint filler.
 11. Adhesive binder.
- E. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory

(CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.

- F. Test Report for Concrete Mix Designs: Trial mixes including water-cement fly ash ratio curves, concrete mix ingredients, and admixtures.
- G. Shoring and Reshoring Sequence: Submit for approval a shoring and reshoring sequence for flat slab/flat plate portions, prepared by a registered Professional Engineer. As a minimum, include timing of form stripping, reshoring, number of floors to be re-shored and timing of re-shore removal to serve as an initial outline of procedures subject to modification as construction progresses. Submit revisions to sequence, whether initiated by Resident Engineer (see FORMWORK) or Contractor.

1.7 DELIVERY, STORAGE, AND HANDLING:

- A. Conform to ACI 304. Store aggregate separately for each kind or grade, to prevent segregation of sizes and avoid inclusion of dirt and other materials.
- B. Deliver cement in original sealed containers bearing name of brand and manufacturer and marked with net weight of contents. Store in suitable watertight building in which floor is raised at least 300 mm (1 foot) above ground. Store bulk cement and fly ash in separate suitable bins.
- C. Deliver other packaged materials for use in concrete in original sealed containers, plainly marked with manufacturer's name and brand, and protect from damage until used.

1.8 PRE-CONCRETE CONFERENCE:

- A. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
- B. Agenda: Includes but is not limited to:
 - 1. Submittals.
 - 2. Coordination of work.
 - 3. Availability of material.
 - 4. Concrete mix design including admixtures.
 - 5. Methods of placing, finishing, and curing.
 - 6. Finish criteria required to obtain required flatness and levelness.
 - 7. Timing of floor finish measurements.

8. Material inspection and testing.

C. Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; lightweight aggregate manufacturer; admixture manufacturers; Resident Engineer; Consulting Engineer; Department of Veterans Affairs retained testing laboratories for concrete testing and finish (F-number) verification.

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

1.9 MOCK-UP:- NOT USED

1.10 APPLICABLE PUBLICATIONS:

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

B. American Concrete Institute (ACI):

117-10Specifications for Tolerances for Concrete Construction and Materials and Commentary

211.1-91 (R2009)Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

214R-11Guide to Evaluation of Strength Test Results of Concrete

301-10Standard Practice for Structural Concrete

304R-00 (R2009)Guide for Measuring, Mixing, Transporting, and Placing Concrete

305.1-06Specification for Hot Weather Concreting

306.1-90 (R2002)Standard Specification for Cold Weather Concreting

308.1-11Specification for Curing Concrete

309R-05Guide for Consolidation of Concrete

318-11Building Code Requirements for Structural Concrete and Commentary

347-04Guide to Formwork for Concrete

SP-66-04ACI Detailing Manual

C. American National Standards Institute and American Hardboard Association (ANSI/AHA):

A135.4-2004Basic Hardboard

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

A82/A82M-07	.....Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A185/185M-07	.....Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
A615/A615M-09	.....Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A653/A653M-11	.....Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
A706/A706M-09	.....Standard Specification for Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A767/A767M-09	.....Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement
A775/A775M-07	.....Standard Specification for Epoxy Coated Reinforcing Steel Bars
A820-11	.....Standard Specification for Steel Fibers for Fiber Reinforced Concrete
A996/A996M-09	.....Standard Specification for Rail Steel and Axle Steel Deformed Bars for Concrete Reinforcement
C31/C31M-10	.....Standard Practice for Making and Curing Concrete Test Specimens in the field
C33/C33M-11A	.....Standard Specification for Concrete Aggregates
C39/C39M-12	.....Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C94/C94M-12	.....Standard Specification for Ready Mixed Concrete
C143/C143M-10	.....Standard Test Method for Slump of Hydraulic Cement Concrete
C150-11	.....Standard Specification for Portland Cement
C171-07	.....Standard Specification for Sheet Materials for Curing Concrete
C172-10	.....Standard Practice for Sampling Freshly Mixed Concrete

C173-10... ..Standard Test Method for Air Content of Freshly
Mixed Concrete by the Volumetric Method

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

C231-10 ..Standard Test Method for Air Content of Freshly
Mixed Concrete by the Pressure Method

C260-10 ..Standard Specification for Air Entraining
Admixtures for Concrete

C309-11 ..Standard Specification for Liquid Membrane
Forming Compounds for Curing Concrete

C330-09 ..Standard Specification for Lightweight
Aggregates for Structural Concrete

C494/C494M-11 ..Standard Specification for Chemical Admixtures
for Concrete

C618-12 ..Standard Specification for Coal Fly Ash and Raw
or Calcined Natural Pozzolan for Use in
Concrete

C666/C666M-03 (R2008) ...Standard Test Method for Resistance of Concrete
to Rapid Freezing and Thawing

C881/C881M-10 ..Standard Specification for Epoxy Resin Base
Bonding Systems for Concrete

C1107/1107M-11 ..Standard Specification for Packaged Dry,
Hydraulic-Cement Grout (Non-shrink)

C1315-11 ..Standard Specification for Liquid Membrane
Forming Compounds Having Special Properties for
Curing and Sealing Concrete

D6-95 (R2011) ..Standard Test Method for Loss on Heating of Oil
and Asphaltic Compounds

D297-93 (R2006) ..Standard Methods for Rubber Products Chemical
Analysis

D412-06AE2 ..Standard Test Methods for Vulcanized Rubber and
Thermoplastic Elastomers - Tension

D1751-04 (R2008) ..Standard Specification for Preformed Expansion
Joint Filler for Concrete Paving and Structural
Construction (Non-extruding and Resilient
Bituminous Types)

- D4263-83(2012)Standard Test Method for Indicating Moisture in
Concrete by the Plastic Sheet Method.
- E1155-96(R2008)Standard Test Method for Determining F_F Floor
Flatness and F_L Floor Levelness Numbers
- F1249-13Standard Test Method for Water Vapor
Transmission Rate Through Plastic Film and
Sheeting Using a Modulated Infrared Sensor

- F1869-11Standard Test Method for Measuring Moisture
Vapor Emission Rate of Concrete Subfloor Using
Anhydrous Calcium Chloride.

E. American Welding Society (AWS):

- D1.4/D1.4M-11Structural Welding Code - Reinforcing Steel

F. Concrete Reinforcing Steel Institute (CRSI):

Handbook 2008

G. National Cooperative Highway Research Program (NCHRP):

- Report onConcrete Sealers for the Protection of Bridge
Structures

H. U. S. Department of Commerce Product Standard (PS):

PS 1Construction and Industrial Plywood

PS 20American Softwood Lumber

I. U. S. Army Corps of Engineers Handbook for Concrete and Cement:

CRD C513Rubber Waterstops

CRD C572Polyvinyl Chloride Waterstops

PART 2 - PRODUCTS:

2.1 FORMS:

- A. Wood: PS 20 free from loose knots and suitable to facilitate finishing
concrete surface specified; tongue and grooved.
- B. Plywood: PS-1 Exterior Grade B-B (concrete-form) 16 mm (5/8 inch), or
20 mm (3/4 inch) thick for unlined contact form. B-B High Density
Concrete Form Overlay optional.
- C. Metal for Concrete Rib-Type Construction: Steel (removal type) of
suitable weight and form to provide required rigidity.

- D. Permanent Steel Form for Concrete Slabs: Corrugated, ASTM A653, Grade E, and Galvanized, ASTM A653, G90. Provide venting where insulating concrete fill is used.
- E. Corrugated Fiberboard Void Boxes: Double faced, completely impregnated with paraffin and laminated with moisture resistant adhesive, size as shown. Design forms to support not less than 48 KPa (1000 psf) and not lose more than 15 percent of their original strength after being completely submerged in water for 24 hours and then air dried.
- F. Form Lining:
1. Hardboard: ANSI/AHA A135.4, Class 2 with one (S1S) smooth side)
 2. Plywood: Grade B-B Exterior (concrete-form) not less than 6 mm (1/4 inch) thick.
 3. Plastic, fiberglass, or elastomeric capable of reproducing the desired pattern or texture.
- G. Concrete products shall comply with following standards for biobased materials:

Material Type	Percent by Weight
Concrete Penetrating Liquid	79 percent biobased material
Concrete form Release Agent	87 percent biobased material
Concrete Sealer	11 percent biobased material

The minimum-content standards are based on the weight (not the volume) of the material.

- H. Form Ties: Develop a minimum working strength of 13.35 kN (3000 pounds) when fully assembled. Ties shall be adjustable in length to permit tightening of forms and not have any lugs, cones, washers to act as spreader within form, nor leave a hole larger than 20 mm (3/4 inch) diameter, or a depression in exposed concrete surface, or leave metal closer than 40 mm (1 1/2 inches) to concrete surface. Wire ties not permitted. Cutting ties back from concrete face not permitted.

2.2 MATERIALS:

- A. Portland Cement: ASTM C150 Type I or II.
- B. Fly Ash: ASTM C618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.

- C. Coarse Aggregate: ASTM C33.
1. Size 67 or Size 467 may be used for footings and walls over 300 mm (12 inches) thick.
 2. Coarse aggregate for applied topping, encasement of steel columns, and metal pan stair fill shall be Size 7.
 3. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourth of minimum clear spacing between reinforcing bars.
- D. Lightweight Aggregates for Structural Concrete: ASTM C330, Table 1. Maximum size of aggregate not larger than one-fifth of narrowest dimension between forms, nor three-fourth of minimum clear distance between reinforcing bars. Contractor to furnish certified report to verify that aggregate is sound and durable and has a durability factor of not less than 80 based on 300 cycles of freezing and thawing when tested in accordance with ASTM C666.
- E. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a 4.75 mm (No. 4) sieve, 10 percent maximum shall pass a 150 μ m (No. 100) sieve.
- F. Mixing Water: Fresh, clean, and potable.
- G. Admixtures:
1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
 2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
 3. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.
 4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
 5. Air Entraining Admixture: ASTM C260.

6. Micro silica: Use only with prior review and acceptance of the Resident Engineer. Use only in conjunction with high range water reducer.
7. Calcium Nitrite corrosion inhibitor: ASTM C494 Type C.
8. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.
9. Certification: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.
- H. Vapor Barrier: ASTM F1249, 0.38 mm (15 mil) WVT 0.007 ft./hr.
- I. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.
- J. Welded Wire Fabric: ASTM A185.
- K. Reinforcing Bars to be Welded: ASTM A706.
- L. Galvanized Reinforcing Bars: ASTM A767.
- M. Epoxy Coated Reinforcing Bars: ASTM A775.
- N. Cold Drawn Steel Wire: ASTM A82.
- O. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.
- P. Expansion Joint Filler: ASTM D1751.
- Q. Sheet Materials for Curing Concrete: ASTM C171.
- R. Liquid Membrane-forming Compounds for Curing Concrete: ASTM C309, Type I, with fugitive dye, and shall meet the requirements of ASTM C1315. Compound shall be compatible with scheduled surface treatment, such as paint and resilient tile, and shall not discolor concrete surface.
- S. Abrasive Aggregate: Aluminum oxide grains or emery grits.
- T. Moisture Vapor Emissions & Alkalinity Control Sealer: 100% active colorless aqueous silicate solution concrete surface.
 1. ASTM C1315 Type 1 Class A, and ASTM C309 Type 1 Class A, penetrating product to have no less than 34% solid content, leaving no sheen, volatile organic compound (VOC) content rating as required to suite regulatory requirements. The product shall have at least a five (5) year documented history in controlling moisture vapor emission from damaging floor covering, compatible with all finish materials.
 2. MVE 15-Year Warranty:

- a. When a floor covering is installed on a below grade, on grade, or above grade concrete slab treated with Moisture Vapor Emissions & Alkalinity Control Sealer according to manufacturer's instruction, sealer manufacturer shall warrant the floor covering system against failure due to moisture vapor migration or moisture-born contaminates for a period of fifteen (15) years from the date of original installation. The warranty shall cover all labor and materials needed to replace all floor covering that fails due to moisture vapor emission & moisture born contaminates.
- U. Penetrating Sealer: For use on parking garage ramps and decks. High penetration silane sealer providing minimum 95 percent screening per National Cooperative Highway Research Program (NCHRP) No. 244 standards for chloride ion penetration resistance. Requires moist (non-membrane) curing of slab.
- V. Non-Shrink Grout:
1. ASTM C1107, pre-mixed, produce a compressive strength of at least 18 MPa at three days and 35 MPa (5000 psi) at 28 days. Furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent bearing under a 1200 mm x 1200 mm (4 foot by 4 foot) base plate.
 2. Where high fluidity or increased placing time is required, furnish test data from an independent laboratory indicating that the grout when placed at a fluid consistency shall achieve 95 percent under a 450 mm x 900 mm (18 inch by 36 inch) base plate.
- W. Adhesive Binder: ASTM C881.
- X. Waterstops:
1. Polyvinyl Chloride Waterstop: CRD C572.
 2. Rubber Waterstops: CRD C513.
 3. Bentonite Waterstop: Flexible strip of bentonite 25 mm x 20 mm (1 inch by 3/4 inch), weighing 8.7 kg/m (5.85 lbs. per foot) composed of Butyl Rubber Hydrocarbon (ASTM D297), Bentonite (SS-S-210-A) and Volatile Matter (ASTM D6).
 4. Non-Metallic Hydrophilic: Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D412 as follows: Tensile strength 420 psi

- minimum; ultimate elongation 600 percent minimum. Hardness shall be 50 minimum on the type A durameter and the volumetric expansion ratio in in 70 deg water shall be 3 to 1 minimum.
- Y. Porous Backfill: Crushed stone or gravel graded from 25 mm to 20 mm (1 inch to 3/4 inch).
- Z. Fibers:
1. Synthetic Fibers: Monofilament or fibrillated polypropylene fibers for secondary reinforcing of concrete members. Use appropriate length and 0.9 kg/m³ (1.5 lb. per cubic yard). Product shall have a UL rating.
 2. Steel Fibers: ASTM A820, Type I cold drawn, high tensile steel wire for use as primary reinforcing in slab-on-grade. Minimum dosage rate 18 kg/m³ (30 lb. per cubic yard).
- AA. Epoxy Joint Filler: Two component, 100 percent solids compound, with a minimum shore D hardness of 50.
- BB. Bonding Admixture: Non-rewettable, polymer modified, bonding compound.
- CC. Architectural Concrete: For areas designated as architectural concrete on the Contract Documents, use colored cements and specially selected aggregates as necessary to produce a concrete of a color and finish which exactly matches the designated sample panel.

2.3 CONCRETE MIXES:

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
 2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, fly ash, admixtures, weight of fine and coarse aggregate per m³ (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement-fly ash ratio, and consistency of each cylinder in terms of slump.
 3. Prepare a curve showing relationship between water-cement -fly ash ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.

4. If the field experience method is used, submit complete standard deviation analysis.
- B. Fly Ash Testing: Submit certificate verifying conformance with ASTM 618 initially with mix design and for each truck load of fly ash delivered from source. Submit test results performed within 6 months of submittal date. Notify Resident Engineer immediately when change in source is anticipated.
1. Testing Laboratory used for fly ash certification/testing shall participate in the Cement and Concrete Reference Laboratory (CCRL) program. Submit most recent CCRL inspection report.
- C. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of Resident Engineer or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement and fly ash, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. Resident Engineer may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and fly ash and approval of design mix.
- D. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums. Use Fly Ash as an admixture with 20% replacement by weight in all structural work. Increase this replacement to 40% for mass concrete and reduce it to 10% for drilled piers and caissons. Fly ash shall not be used in high-early mix design.

E. TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement Kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio	Min. Cement Kg/m ³ (lbs/c. yd)	Max. Water Cement Ratio
35 (5000) ^{1,3}	375 (630)	0.45	385 (650)	0.40
30 (4000) ^{1,3}	325 (550)	0.55	340 (570)	0.50
25 (3000) ^{1,3}	280 (470)	0.65	290 (490)	0.55
25 (3000) ^{1,2}	300 (500)	*	310 (520)	*

1. If trial mixes are used, the proposed mix design shall achieve a compressive strength 8.3 MPa (1200 psi) in excess of f'c. For concrete strengths above 35 Mpa (5000 psi), the proposed mix design shall achieve a compressive strength 9.7 MPa (1400 psi) in excess of f'c.
2. Lightweight Structural Concrete. Pump mixes may require higher cement values.
3. For concrete exposed to high sulfate content soils maximum water cement ratio is 0.44.
4. Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.

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

TABLE II - MAXIMUM SLUMP, MM (INCHES) *

Type of Construction	Normal Weight Concrete	Lightweight Structural Concrete
Reinforced Footings and Substructure Walls	75mm (3 inches)	75 mm (3 inches)

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

**TABLE III - TOTAL AIR CONTENT
FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

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

**TABLE IV
AIR CONTENT OF LIGHTWEIGHT STRUCTURAL CONCRETE**

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

- H. High early strength concrete, made with Type III cement or Type I cement plus non-corrosive accelerator, shall have a 7-day compressive strength equal to specified minimum 28-day compressive strength for concrete type specified made with standard Portland cement.

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

results from cores tested by the Contractor retained testing agency to analyze structure.

4. If strength of core drilled specimens falls below 85 percent of minimum value given in Table I, Resident Engineer may order load tests, made by Contractor retained testing agency, on portions of building so affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.
5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the Resident Engineer.

2.4 BATCHING AND MIXING:

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

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

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

PART 3 - EXECUTION**3.1 FORMWORK:**

- A. General: Design in accordance with ACI 347 is the responsibility of the Contractor. The Contractor shall retain a registered Professional Engineer to design the formwork, shores, and reshores.
1. Form boards and plywood forms may be reused for contact surfaces of exposed concrete only if thoroughly cleaned, patched, and repaired and Resident Engineer approves their reuse.
 2. Provide forms for concrete footings unless Resident Engineer determines forms are not necessary.
 3. Corrugated fiberboard forms: Place forms on a smooth firm bed, set tight, with no buckled cartons to prevent horizontal displacement, and in a dry condition when concrete is placed.
- B. Treating and Wetting: Treat or wet contact forms as follows:
1. Coat plywood and board forms with non-staining form sealer. In hot weather, cool forms by wetting with cool water just before concrete is placed.
 2. Clean and coat removable metal forms with light form oil before reinforcement is placed. In hot weather, cool metal forms by thoroughly wetting with water just before placing concrete.
 3. Use sealer on reused plywood forms as specified for new material.
- C. Size and Spacing of Studs: Size and space studs, wales and other framing members for wall forms so as not to exceed safe working stress of kind of lumber used nor to develop deflection greater than $1/270$ of free span of member.
- D. Unlined Forms: Use plywood forms to obtain a smooth finish for concrete surfaces. Tightly butt edges of sheets to prevent leakage. Back up all vertical joints solidly and nail edges of adjacent sheets to same stud with 6d box nails spaced not over 150 mm (6 inches) apart.
- E. Lined Forms: May be used in lieu of unlined plywood forms. Back up form lining solidly with square edge board lumber securely nailed to studs with all edges in close contact to prevent bulging of lining. No joints in lining and backing may coincide. Nail abutted edges of sheets to same backing board. Nail lining at not over 200 mm (8 inches) on center along edges and with at least one nail to each square foot of surface

area; nails to be 3d blued shingle or similar nails with thin flatheads.

- F. Architectural Liner: Attach liner as recommended by the manufacturer with tight joints to prevent leakage.
- G. Wall Form Ties: Locate wall form ties in symmetrically level horizontal rows at each line of wales and in plumb vertical tiers. Space ties to maintain true, plumb surfaces. Provide one row of ties within 150 mm (6 inches) above each construction joint. Space through-ties adjacent to horizontal and vertical construction joints not over 450 mm (18 inches) on center.
 - 1. Tighten row of ties at bottom of form just before placing concrete and, if necessary, during placing of concrete to prevent seepage of concrete and to obtain a clean line. Ties to be entirely removed shall be loosened 24 hours after concrete is placed and shall be pulled from least important face when removed.
 - 2. Coat surfaces of all metal that is to be removed with paraffin, cup grease or a suitable compound to facilitate removal.
- H. Inserts, Sleeves, and Similar Items: Flashing reglets, steel strips, masonry ties, anchors, wood blocks, nailing strips, grounds, inserts, wire hangers, sleeves, drains, guard angles, forms for floor hinge boxes, inserts or bond blocks for elevator guide rails and supports, and other items specified as furnished under this and other sections of specifications and required to be in their final position at time concrete is placed shall be properly located, accurately positioned, and built into construction, and maintained securely in place.
 - 1. Locate inserts or hanger wires for furred and suspended ceilings only in bottom of concrete joists, or similar concrete member of overhead concrete joist construction.
 - 2. Install sleeves, inserts and similar items for mechanical services in accordance with drawings prepared specially for mechanical services. Contractor is responsible for accuracy and completeness of drawings and shall coordinate requirements for mechanical services and equipment.
 - 3. Do not install sleeves in beams, joists or columns except where shown or permitted by Resident Engineer. Install sleeves in beams, joists, or columns that are not shown, but are permitted by the

Resident Engineer, and require no structural changes, at no additional cost to the Government.

4. Minimum clear distance of embedded items such as conduit and pipe is at least three times diameter of conduit or pipe, except at stub-ups and other similar locations.
5. Provide recesses and block outs in floor slabs for door closers and other hardware as necessary in accordance with manufacturer's instructions.

I. Construction Tolerances:

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

3.2 PLACING REINFORCEMENT:

- A. General: Details of concrete reinforcement in accordance with ACI 318 unless otherwise shown.
- B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.
 1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Use epoxy-coated tie wire with epoxy-coated reinforcing. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 318. Where concrete slabs are placed on ground, use concrete blocks or other non-corrodible material of proper height, for support of reinforcement. Use of brick or stone supports will not be permitted.

2. Lap welded wire fabric at least 1 1/2 mesh panels plus end extension of wires not less than 300 mm (12 inches) in structural slabs. Lap welded wire fabric at least 1/2 mesh panels plus end extension of wires not less than 150 mm (6 inches) in slabs on grade.
 3. Splice column steel at no points other than at footings and floor levels unless otherwise shown.
- C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate.
- D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:
1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11). Minimum lengths of lap as shown.
 2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength (fy) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
 - a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
 - b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
 - c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by Resident Engineer.
 3. Mechanical Splices: Develop in tension and compression at least 125 percent of the yield strength (fy) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
 - a. Initial qualification: In the presence of Resident Engineer, make three test mechanical splices of each bar size proposed to be

spliced. Department of Veterans Affairs retained testing laboratory will perform load test.

- b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.
- E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Resident Engineer.
- F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.
- G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

3.3 VAPOR BARRIER:

- A. Except where membrane waterproofing is required, interior concrete slab on grade shall be placed on a continuous vapor barrier.
 - 1. Place 100 mm (4 inches) of fine granular fill over the vapor barrier to act as a blotter for concrete slab.
 - 2. Vapor barrier joints lapped 150 mm (6 inches) and sealed with compatible waterproof pressure-sensitive tape.
 - 3. Patch punctures and tears.

3.4 SLABS RECEIVING RESILIENT COVERING

- A. Slab shall be allowed to cure for 6 weeks minimum prior to placing resilient covering. After curing, slab shall be tested by the Contractor for moisture in accordance with ASTM D4263 or ASTM F1869. Moisture content shall be less than 3 pounds per 1000 sf prior to placing covering.
- B. In lieu of curing for 6 weeks, Contractor has the option, at his own cost, to utilize the Moisture Vapor Emissions & Alkalinity Control Sealer as follows:
 - 1. Sealer is applied on the day of the concrete pour or as soon as harsh weather permits, prior to any other chemical treatments for concrete slabs either on grade, below grade or above grade receiving

resilient flooring, such as, sheet vinyl, vinyl composition tile, rubber, wood flooring, epoxy coatings and overlays.

2. Manufacturer's representative will be on the site the day of concrete pour to install or train its application and document. He shall return on every application thereafter to verify that proper procedures are followed.
 - a. Apply Sealer to concrete slabs as soon as final finishing operations are complete and the concrete has hardened sufficiently to sustain floor traffic without damage.
 - b. Spray apply Sealer at the rate of 20 m² (200 square feet) per gallon. Lightly broom product evenly over the substrate and product has completely penetrated the surface.
 - c. If within two (2) hours after initial application areas are subjected to heavy rainfall and puddling occurs, reapply Sealer product to these areas as soon as weather condition permits.

3.5 CONSTRUCTION JOINTS:

- A. Unless otherwise shown, location of construction joints to limit individual placement shall not exceed 24,000 mm (80 feet) in any horizontal direction, except slabs on grade which shall have construction joints shown. Allow 48 hours to elapse between pouring adjacent sections unless this requirement is waived by Resident Engineer.
- B. Locate construction joints in suspended floors near the quarter-point of spans for slabs, beams or girders, unless a beam intersects a girder at center, in which case joint in girder shall be offset a distance equal to twice width of beam. Provide keys and inclined dowels as shown. Provide longitudinal keys as shown.
- C. Place concrete for columns slowly and in one operation between joints. Install joints in concrete columns at underside of deepest beam or girder framing into column.
- D. Allow 2 hours to elapse after column is cast before concrete of supported beam, girder or slab is placed. Place girders, beams, grade beams, column capitals, brackets, and haunches at the same time as slab unless otherwise shown.

- E. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.

3.6 EXPANSION JOINTS AND CONTRACTION JOINTS:

- A. Clean expansion joint surfaces before installing premolded filler and placing adjacent concrete.
- B. Install polyvinyl chloride or rubber water seals, as shown in accordance with manufacturer's instructions, to form continuous watertight seal.
- C. Provide contraction (control) joints in floor slabs as indicated on the contract drawings. Joints shall be either formed or saw cut, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.7 PLACING CONCRETE:

- A. Preparation:
 - 1. Remove hardened concrete, wood chips, shavings and other debris from forms.
 - 2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
 - 3. Have forms and reinforcement inspected and approved by Resident Engineer before depositing concrete.
 - 4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.
- B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.
 - 1. Preparing surface for applied topping:
 - a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
 - b. Broom clean and keep base slab wet for at least four hours before topping is applied.

- c. Use a thin coat of one part portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.
- C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete is subject to approval of Resident Engineer.
- D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.
 - 1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
 - 2. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
 - 3. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (superplasticizer) or 1500 mm (5 feet) for conventional concrete. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.
 - 4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
 - 5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
 - 6. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (superplasticizer).

Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.

7. Concrete on metal deck:

a. Concrete on metal deck shall be minimum thickness shown. Allow for deflection of steel beams and metal deck under the weight of wet concrete in calculating concrete quantities for slab.

- 1) The Contractor shall become familiar with deflection characteristics of structural frame to include proper amount of additional concrete due to beam/deck deflection.

E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000 cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.

1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

3.8 HOT WEATHER:

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

3.9 COLD WEATHER:

Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than

0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Resident Engineer.

3.10 PROTECTION AND CURING:

- A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Resident Engineer.
1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage 10m²/L (400 square feet per gallon) on steel troweled surfaces and 7.5m²/L (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
 2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.
 3. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

3.11 REMOVAL OF FORMS:

- A. Remove in a manner to assure complete safety of structure after the following conditions have been met.
1. Where structure as a whole is supported on shores, forms for beams and girder sides, columns, and similar vertical structural members may be removed after 24 hours, provided concrete has hardened sufficiently to prevent surface damage and curing is continued without any lapse in time as specified for exposed surfaces.

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

3.12 CONCRETE SURFACE PREPARATION:

- A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.
- B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 25 mm (1 inch). Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 150 mm (6 inches) surrounding before placing patching mortar. Give area to be patched a brush coat of cement grout followed immediately by patching mortar. Cement grout composed of one part Portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio, mix to achieve consistency of thick paint. Mix patching mortar approximately 1 hour before placing and remix occasionally during this period without addition of water. Compact mortar into place and screed slightly higher

than surrounding surface. After initial shrinkage has occurred, finish to match color and texture of adjoining surfaces. Cure patches as specified for other concrete. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.

- C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose aggregates to provide a clean, firm, granular surface for bond of applied finish.

3.13 CONCRETE FINISHES:

- A. Vertical and Overhead Surface Finishes:
 - 1. Unfinished areas: Vertical and overhead concrete surfaces exposed in pipe basements, elevator and dumbwaiter shafts, pipe spaces, pipe trenches, above suspended ceilings, manholes, and other unfinished areas will not require additional finishing.
 - 2. Interior and exterior exposed areas to be painted: Remove fins, burrs and similar projections on surfaces flush, and smooth by mechanical means approved by Resident Engineer, and by rubbing lightly with a fine abrasive stone or hone. Use ample water during rubbing without working up a lather of mortar or changing texture of concrete.
 - 3. Interior and exterior exposed areas finished: Give a grout finish of uniform color and smooth finish treated as follows:
 - a. After concrete has hardened and laitance, fins and burrs removed, scrub concrete with wire brushes. Clean stained concrete surfaces by use of a hone stone.
 - b. Apply grout composed of one part of Portland cement, one part fine sand, smaller than a 600 μm (No. 30) sieve. Work grout into surface of concrete with cork floats or fiber brushes until all pits, and honeycombs are filled.
 - c. After grout has hardened slightly, but while still plastic, scrape grout off with a sponge rubber float and, about 1 hour later, rub concrete vigorously with burlap to remove any excess grout remaining on surfaces.

- d. In hot, dry weather use a fog spray to keep grout wet during setting period. Complete finish of area in same day. Make limits of finished areas at natural breaks in wall surface. Leave no grout on concrete surface overnight.
 4. Textured: Finish as specified. Maximum quantity of patched area 0.2 m² (2 square feet) in each 93 m² (1000 square feet) of textured surface.
- B. Slab Finishes:
1. Monitoring and Adjustment: Provide continuous cycle of placement, measurement, evaluation and adjustment of procedures to produce slabs within specified tolerances. Monitor elevations of structural steel in key locations before and after concrete placement to establish typical deflection patterns for the structural steel. Determine elevations of cast-in-place slab soffits prior to removal of shores. Provide information to Resident Engineer and floor consultant for evaluation and recommendations for subsequent placements.
 2. Set perimeter forms to serve as screed using either optical or laser instruments. For slabs on grade, wet screeds may be used to establish initial grade during strike-off, unless Resident Engineer determines that the method is proving insufficient to meet required finish tolerances and directs use of rigid screed guides. Where wet screeds are allowed, they shall be placed using grade stakes set by optical or laser instruments. Use rigid screed guides, as opposed to wet screeds, to control strike-off elevation for all types of elevated (non-slab-on-grade) slabs. Divide bays into halves or thirds by hard screeds. Adjust as necessary where monitoring of previous placements indicates unshored structural steel deflections to other than a level profile.
 3. Place slabs monolithically. Once slab placement commences, complete finishing operations within same day. Slope finished slab to floor drains where they occur, whether shown or not.
 4. Use straightedges specifically made for screeding, such as hollow magnesium straightedges or power strike-offs. Do not use pieces of dimensioned lumber. Strike off and screed slab to a true surface at required elevations. Use optical or laser instruments to check

- concrete finished surface grade after strike-off. Repeat strike-off as necessary. Complete screeding before any excess moisture or bleeding water is present on surface. Do not sprinkle dry cement on the surface.
5. Immediately following screeding, and before any bleed water appears, use a 3000 mm (10 foot) wide highway straightedge in a cutting and filling operation to achieve surface flatness. Do not use bull floats or darbys, except that darbying may be allowed for narrow slabs and restricted spaces.
 6. Wait until water sheen disappears and surface stiffens before proceeding further. Do not perform subsequent operations until concrete will sustain foot pressure with maximum of 6 mm (1/4 inch) indentation.
 7. Scratch Finish: Finish base slab to receive a bonded applied cementitious application as indicated above, except that bull floats and darbys may be used. Thoroughly coarse wire broom within two hours after placing to roughen slab surface to insure a permanent bond between base slab and applied materials.
 8. Float Finish: Slabs to receive unbonded toppings, steel trowel finish, fill, mortar setting beds, or a built-up roof, and ramps, stair treads, platforms (interior and exterior), and equipment pads shall be floated to a smooth, dense uniform, sandy textured finish. During floating, while surface is still soft, check surface for flatness using a 3000 mm (10 foot) highway straightedge. Correct high spots by cutting down and correct low spots by filling in with material of same composition as floor finish. Remove any surface projections and re-float to a uniform texture.
 9. Steel Trowel Finish: Concrete surfaces to receive resilient floor covering or carpet, monolithic floor slabs to be exposed to view in finished work, future floor roof slabs, applied toppings, and other interior surfaces for which no other finish is indicated. Steel trowel immediately following floating. During final troweling, tilt steel trowel at a slight angle and exert heavy pressure to compact cement paste and form a dense, smooth surface. Finished surface shall be smooth, free of trowel marks, and uniform in texture and appearance.

10. Broom Finish: Finish exterior slabs, ramps, and stair treads with a bristle brush moistened with clear water after surfaces have been floated. Brush in a direction transverse to main traffic. Match texture approved by Resident Engineer from sample panel.
11. Finished slab flatness (FF) and levelness (FL) values comply with the following minimum requirements:
- a. Areas covered with carpeting, or not specified otherwise in b. below:
- 1) Slab on Grade:
 - a) Specified overall value FF 25/FL 20
 - b) Minimum local value FF 17/FL 15
 - 2) Level suspended slabs (shored until after testing) and topping slabs:
 - a) Specified overall value FF 25/FL 20
 - b) Minimum local value FF 17/FL 15
 - 3) Unshored suspended slabs:
 - a) Specified overall value FF 25
 - b) Minimum local value FF 17
 - 4) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.
- b. Areas that will be exposed, receive thin-set tile or resilient flooring, or roof areas designed as future floors:
- 1) Slab on grade:
 - a) Specified overall value FF 36/FL 20
 - b) Minimum local value FF 24/FL 15
 - 2) Level suspended slabs (shored until after testing) and topping slabs
 - a) Specified overall value FF 30/FL 20
 - b) Minimum local value FF 24/FL 15
 - 3) Unshored suspended slabs:
 - a) Specified overall value FF 30
 - b) Minimum local value FF 24
 - 4) Level tolerance such that 80 percent of all points fall within a 20 mm (3/4 inch) envelope +10 mm, -10 mm (+3/8 inch, -3/8 inch) from the design elevation.

- c. "Specified overall value" is based on the composite of all measured values in a placement derived in accordance with ASTM E1155.
- d. "Minimum local value" (MLV) describes the flatness or levelness below which repair or replacement is required. MLV is based on the results of an individual placement and applies to a minimum local area. Minimum local area boundaries may not cross a construction joint or expansion joint. A minimum local area will be bounded by construction and/or control joints, or by column lines and/or half-column lines, whichever is smaller.

12. Measurements

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

13. Acceptance/ Rejection:

- a. If individual slab section measures less than either of specified minimum local F_F/F_L numbers, that section shall be rejected and remedial measures shall be required. Sectional boundaries may be set at construction and contraction (control) joints, and not smaller than one-half bay.

- b. If composite value of entire slab installation, combination of all local results, measures less than either of specified overall F_F/F_L numbers, then whole slab shall be rejected and remedial measures shall be required.
14. Remedial Measures for Rejected Slabs: Correct rejected slab areas by grinding, planing, surface repair with underlayment compound or repair topping, re-topping, or removal and replacement of entire rejected slab areas, as directed by Resident Engineer, until a slab finish constructed within specified tolerances is accepted.

3.14 SURFACE TREATMENTS:

- A. Use on exposed concrete floors and concrete floors to receive carpeting except those specified to receive non-slip finish.
- B. Liquid Densifier/Sealer: Apply in accordance with manufacturer's directions just prior to completion of construction.
- C. Non-Slip Finish: Except where safety nosing and tread coverings are shown, apply non-slip abrasive aggregate to treads and platforms of concrete steps and stairs, and to surfaces of exterior concrete ramps and platforms. Broadcast aggregate uniformly over concrete surface at rate of application of 8% per 1/10th m² (7.5 percent per square foot) of area. Trowel concrete surface to smooth dense finish. After curing, rub treated surface with abrasive brick and water to slightly expose abrasive aggregate.

3.15 APPLIED TOPPING:

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

3.16 RESURFACING FLOORS:

Remove existing flooring areas to receive resurfacing to expose existing structural slab and extend not less than 25 mm (1 inch) below new finished floor level. Prepare exposed structural slab surface by roughening, broom cleaning, and dampening. Apply specified bonding grout. Place topping while the bonding grout is still tacky.

3.17 RETAINING WALLS:

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

3.18 PRECAST CONCRETE ITEMS:

Precast concrete items, not specified elsewhere. Cast using 25 MPa (3000 psi) air-entrained concrete to shapes and dimensions shown. Finish to match corresponding adjacent concrete surfaces. Reinforce with steel for safe handling and erection.

- - - E N D - - -

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Structural steel shapes, plates, and bars.
 - 2. Structural pipe.
 - 3. Bolts, nuts, and washers.

1.2 RELATED REQUIREMENTS

- A. Materials Testing and Inspection During Construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Roof Decks Framing: Section 03 51 16, GYPSUM CONCRETE ROOF DECKS.
- C. Floor Decks Framing: Section 03 55 11, GYPSUM CONCRETE FLOOR DECKS.
- D. Steel Joist: Section 05 21 00, STEEL JOIST FRAMING.
- E. Steel Decking: Section 05 31 00, STEEL DECKING.
- F. Composite Steel Deck: Section 05 36 00, COMPOSITE METAL DECKING.
- G. Fireproofing: Section 07 81 00, APPLIED FIREPROOFING.
- H. Steel Finishes: Section 09 06 00, SCHEDULE FOR FINISHES.
- I. Steel Support: Section 10 13 00, DIRECTORIES.
- J. Painting: Section 09 91 00, PAINTING.
- K. Steel Piles: Section 31 62 00, DRIVEN PILES.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Institute of Steel Construction (AISC):
 - 1. AISC Manual - Steel Construction Manual, 14th Ed.
 - 2. 303-10 - Code of Structural Steel Buildings and Bridges.
 - 3. 360-10: Specification for Structural Steel Buildings.
- C. The American Society of Mechanical Engineers (ASME):
 - 1. B18.22.1-09 - Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers.
- D. American Welding Society (AWS):
 - 1. D1.1/D1.1M-15 - Structural Welding Code - Steel.
- E. ASTM International (ASTM):
 - 1. A6/A6M-14 - General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

2. A36/A36M-14 - Carbon Structural Steel.
 3. A53/A53M-12 - Pipe, Steel, Black and Hot-Dip, Zinc-Coated, Welded and Seamless.
 4. A123/A123M-15 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 5. A242/A242M-13 - High-Strength Low-Alloy Structural Steel.
 6. A283/A283M-13 - Low and Intermediate Tensile Strength Carbon Steel Plates.
 7. A307-14 - Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 8. A500/A500M-13 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.
 9. A501/A501M-14 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing and Rounds and Shapes.
 10. A572/A572M-15 - High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
 11. A992/A992M-15 - Structural Shapes.
 12. F2329/F2329M-15 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy steel Bolts, Screws, washers, Nuts, and Special Threaded Fasteners.
 13. F3125/F3125M-15 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
- F. Master Painters Institute (MPI):
1. No. 18 - Primer, Zinc Rich, Organic.
- G. Military Specifications (Mil. Spec.):
1. MIL-P-21035 - Paint, High Zinc Dust Content, Galvanizing, Repair.
- H. Occupational Safety and Health Administration (OSHA):
1. 29 CFR 1926.752(e) - Guidelines For Establishing The Components Of A Site-Specific Erection Plan.
 2. 29 CFR 1926-2001 - Safety Standards for Steel Erection.
- I. Research Council on Structural Connections (RCSC) of The Engineering Foundation:
1. Specification for Structural Joints Using ASTM F3125 Bolts.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
 - 1. Show size, configuration, and fabrication and installation details.
- C. Sustainable Construction Submittals:
 - 1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
- D. Test Reports: Certify products comply with specifications.
 - 1. Welders' qualifying tests.
- E. Certificates: Certify each product complies with specifications.
 - 1. Structural steel.
 - 2. Steel connections.
 - 3. Welding materials.
 - 4. Shop coat primer paint.
- F. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Fabricator with project experience list
 - 2. Installer with project experience list
 - 3. Welders and welding procedures.
- G. Delegated Design Drawings and Calculations: Signed and sealed by responsible Architect/Engineer.
 - 1. Connection calculations.
- H. Record Surveys: Signed and sealed by responsible surveyor or engineer.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: AISC Quality Certification participant designated as AISC Certified Plant, Category STD.
 - 1. Regularly fabricates specified products.
 - 2. Fabricated specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Installer Qualifications: AISC Quality Certification Program participant designated as AISC-Certified Erector, Category ACSE.
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.

- a. Project Experience List: Provide contact names and addresses for completed projects.
- C. Before commencement of Work, ensure steel erector provides written notification required by OSHA 29 CFR 1926.752(e). Submit a copy of the notification to Contracting Officer's Representative.
- D. Welders and Welding Procedures Qualifications: AWS D1.1/D1.1M.

1.6 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where project is located.
- B. Design structural steel framing connections complying with specified performance:
 - 1. Load Capacity: Resist loads indicated on drawings. Account for connection and member loads and eccentricities.
 - a. Request additional design criteria when necessary to complete connection design.
 - 2. Configuration: Design and detail all connections for each member size, steel grade and connection type to resist the loads and reactions indicated on the drawings or specified herein. Use details consistent with details shown on drawings, supplementing where necessary. The details shown on drawings are conceptual and do not indicate the required weld sizes or number of bolts unless specifically noted. Use rational engineering design and standard practice in detailing, accounting for all loads and eccentricities in both the connection and the members. Promptly notify the Contracting Officer Representative of any location where the connection design criteria is not clearly indicated. The design of all connections is subject to the review and acceptance of the Contracting Officer's Representative. Submit structural calculations prepared and sealed by a qualified engineer registered in the state

where the project is located. Submit calculations for review before preparation of detail drawings.

2.2 MATERIALS

A. W-Shapes:

1. ASTM A992/A992M.
2. ASTM A572/A572M; Grade 50
3. ASTM A529; Grade 50

B. M -Shapes:

1. ASTM A36/A36M.
2. ASTM A572/A572M; Grade 50
3. ASTM A529; Grade 50

C. Channel and Angles:

1. ASTM A36/A36M.
2. ASTM A572/A572M; Grade 50
3. ASTM A529; Grade 50

D. Plates and Bars:

1. ASTM A36/A36M.
2. ASTM A572/A572M; Grade 50
3. ASTM A529; Grade 50

E. Hollow Structural Sections:

1. ASTM A500/A500M.
2. ASTM A501/A501M.

F. Structural Pipe: ASTM A53/A53M, Grade B.

G. Bolts, Nuts and Washers: Galvanized for galvanized framing and plain finish for other framing .

1. High-strength bolts, including nuts and washers: ASTM F3125.
2. Bolts and nuts, other than high-strength: ASTM A307, Grade A.
3. Plain washers, other than those in contact with high-strength bolt heads and nuts: ASME B18.22.1.

H. Welding Materials: AWS D1.1, type to suit application.

2.3 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Sustainable Construction Requirements:

1. Steel Recycled Content: 30 percent total recycled content, minimum.

2. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
 - a. Paints and coatings.

2.4 FABRICATION

- A. Fabricate structural steel according to Chapter M, AISC 360.
- B. Shop and Field Connections:
 1. Weld connections according to AWS D1.1/D1.1M. Welds shall be made only by welders and welding operators who have been previously qualified by tests as prescribed in AWS D1.1 to perform type of work required.
 2. High-Strength Bolts: High-strength bolts tightened to a bolt tension minimum 70 percent of their minimum tensile strength. Tightening done with properly calibrated wrenches, by turn-of-nut method or by use of direct tension indicators (bolts or washers). Tighten bolts in connections identified as slip-critical using Direct Tension Indicators. Twist-off torque bolts are not an acceptable alternate fastener for slip critical connections.

2.5 FINISHES

- A. Shop Priming:
 1. Prime paint structural steel according to AISC 303, Section 6.
 - a. Interstitial Space Structural Steel: Prime paint, unless indicated to receive sprayed on fireproofing.
- B. Shop Finish Painting: Apply primer and finish paint as specified in Section 09 91 00, PAINTING.
- C. Do not paint:
 1. Surfaces within 50 mm (2 inches) of field welded joints.
 2. Surfaces indicated to be encased in concrete.
 3. Surfaces receiving sprayed on fireproofing.
 4. Beam top flanges receiving shear connector studs applied.
- D. Structural Steel Galvanizing: ASTM A123/A123M, hot dipped, after fabrication. Touch-up after erection: Clean and wire brush any abraded and other spots worn through zinc coating, including threaded portions of bolts and welds and touch-up with galvanizing repair paint.
 1. Galvanize structural steel framing installed at exterior locations.

- E. Bolts, Nuts, and Washers Galvanizing: ASTM F2329, hot-dipped.

2.6 ACCESSORIES

- A. General: Shop paint steel according to AISC 303, Section 6.
- B. Finish Paint System: Primer and finish as specified in Section 09 91 00, PAINTING.
- C. Galvanizing Repair Paint: MPI No. 18.

PART 3 - EXECUTION

3.1 ERECTION

- A. Erect structural steel according to AISC 303 and AISC 360.
- B. Set structural steel accurately at locations and elevations indicated on drawings.
- C. Maintain erection tolerances of structural steel within AISC 303 requirements.
 - 1. Pour Stop Elevation Tolerance: 6 mm (1/4 inch), maximum, before concrete placement.
- D. Weld and bolt connections as specified for shop connections.

3.2 FIELD PAINTING

- A. After welding, clean and prime weld areas to match adjacent finish.
- B. Touch-up primer damaged by construction operations.
- C. Apply galvanizing repair paint to galvanized coatings damaged by construction operations.
- D. Finish Painting: As specified in Section 09 91 00, PAINTING.

3.3 FIELD QUALITY CONTROL

- A. Record Survey:
 - 1. Engage registered land surveyor or registered civil engineer as specified in Section 01 00 00, GENERAL REQUIREMENTS to perform survey.
 - 2. Measure and record structural steel framing plumbness, level, and alignment after completing bolting and welding and before installation of work supported by structural steel.
 - 3. Identify deviations from allowable tolerances specified in AISC Manual.

- - E N D - -

SECTION 05 15 13
WIRE ROPE ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Stainless steel structural support wire rope assemblies.
 - 1. Braces and Trusses.
 - 2. Structural Ties.
 - 3. Suspension Cables.
 - 4. Tension Elements.

- B. Stainless steel fabric structure wire rope assemblies.
 - 1. Membrane Structures.
 - 2. Shade Structures.
 - 3. Lightweight Roofing.

- C. Stainless steel structural support rod assemblies.
 - 1. Suspension Rods.
 - 2. Tension Elements.
 - 3. Structural Ties.
 - 4. Support rods.

- D. Stainless steel signage wire rope assemblies.

- E. Stainless steel suspended shelving wire rope assemblies.

- F. Stainless steel protective barrier netting wire rope assemblies.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 04 40 00 - Stone Assemblies.
- C. Section 05 10 00 - Structural Metal Framing.
- D. Section 05 50 00 - Metal Fabrications.
- E. Section 05 73 00 - Decorative Metal Railings.
- F. Section 06 10 00 - Rough Carpentry.
- G. Section 10 14 00 - Signage.
- H. Section 13 31 23 - Tensioned Fabric Structures.

1.3 REFERENCES

- A. American Iron and Steel Institute (AISI) - Manual of Steel Construction; Design, Fabrication and Erection of Structural Steel Buildings.

- B. American Iron and Steel Institute (AISI) - Steel Product Manual; Stainless and Heat Resisting Steel.

- C. American Iron and Steel Institute (AISI): The Design of Fabrication of Cold Formed Steel Structures.
- D. ASTM A 276 - Stainless and Heat-Resisting Steel Bars and Shapes.
- E. ASTM A 380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.
- F. ASTM A 492 - Specification for Stainless Steel Rope Wire.
- G. ASTM A 555 - Stainless Steel Wire.
- H. ASTM A 582 - Specification for Free-Machining Stainless and Heat-Resisting Steel Bars.
- I. ASTM B 912 - Specification for Passivation of Stainless Steels Using Electropolishing.
- J. ASTM F 1145 - Specification for Turnbuckles, Swaged, Welded, Forged.
- K. MIL-C-5688 - Pre-Stretching and Proof-Testing of Wire Rope Assemblies.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Structural Requirements: Provide stainless steel wire rope assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated on the Drawings:
 1. Components: to withstand dead load, applicable snow load, vertical and horizontal seismic loads, and design loads due to pressure and suction of wind calculated in accordance with applicable building code.
 2. Cooperate with regulatory agency or authority and provide data as requested authority having jurisdiction.
 3. Primary and secondary support framing shall comply with current issues of AISC, AISI, and ASTM specifications, as applicable.
 4. Design supports and hardware to withstand loads encountered without excessive deflection or distortion when cables are tensioned to required loading and to conform to building codes.
- B. Wire rope assemblies shall be designed, fabricated, and installed to accommodate expansion and contraction of metal components without causing undue stress, buckling, opening of joints, and distortion. Design for the following minimum temperature ranges.
 1. Ambient Temperature Range: 120 degrees F (67 degrees C).
 2. Material Surface Temperature Range: 180 degrees F (100 degrees C).
- C. Design supports and hardware to withstand loads encountered without excessive deflection or distortion when cables are tensioned to required amounts required to conform to applicable building codes.
- D. Components shall be free from defects impairing strength, durability and appearance. Exposed surfaces throughout system shall have same inherent texture and color for similar locations.
- E. Design system to prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- F. Exposed fasteners shall be of same materials, color and finish as material to which applied. Exposed surfaces throughout project shall have same inherent texture and color for similar locations.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards. Provide list of fittings being provided with descriptions, load capabilities, and either photographs or drawings for each type.
- C. Shop Drawings: Submit Shop Drawings for fabrication and installation. Include the following:
 - 1. Plans, elevations, and detail sections.
 - 2. Indicate materials, methods, finishes, fittings, fasteners, anchorages, and accessory items.
 - 3. Provide setting diagrams and templates for anchorages, sleeves, and bolts to be installed by others.
 - 4. Where materials or fabrications are indicated to comply with design loadings, include material and safety factor properties, and other information needed for structural analysis.
- D. Verification Samples: Two samples representing actual products and finishes as follows:
 - 1. Wire rope with fitting, minimum size 12 inches (300 mm) long.
 - 2. Rods, minimum size 12 inches (300 mm) long.
 - 3. Typical fittings.
- E. Installation Instructions: Manufacturer's printed installation instructions.
- F. Operation and Maintenance Data: Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
- G. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturer of stainless steel wire rope, fittings, and other stainless steel components with 10 years minimum successful experience.
- B. Installer Qualifications: Experienced in performing work of this section that has specialized in installation of work similar to that required for this project.
- C. Mock-Up: Provide a mock-up for evaluation of preparation techniques and installation workmanship.
 - 1. Locate in areas designated by Architect.
 - 2. Size: Minimum of 10 SF (1 sm) and including typical anchors and connections.
 - 3. Do not proceed with remaining work until workmanship is approved by Architect.
 - 4. Rework mock-up as required to produce acceptable work.
 - 5. Retain mock-up during construction as quality standard.
 - 6. Remove and legally dispose of mock-up when no longer needed.
 - 7. Incorporation: Incorporate mock-up into final construction.
- D. Preinstallation Meetings: Conduct meetings including Contractor, Architect, fabricator, installer and other subcontractors whose work involves wire rope assemblies to verify project requirements, foundations, supports, framing and support conditions, mounting surfaces and manufacturer's installation requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. All individual parts and packages of identical parts are to be clearly marked for identification.

The packing list shall include the description, quantity and piece mark of the parts, components and elements.

- C. Handle and store products according to manufacturer's recommendations. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- D. Exercise care not to scratch, mark, dent, or bend metal components during delivery, storage, and installation.

1.8 PROJECT CONDITIONS

- A. Verify actual openings by field measurements before fabrication; show recorded measurements on shop drawings.
- B. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Provide all cable, materials, fittings and components from a single manufacturer.

2.2 ASSEMBLIES

- A. Provide Jacob, Inc. INOX Line stainless steel wire rope assembly components as specified and as indicated on the Drawings. Manufacturer shall engineer and fabricate components and assemblies for installation. Design requirements for individual components and wire rope shall be as indicated on the Drawings.
- B. Stainless steel structural support wire rope assemblies including.
 - 1. Braces and Trusses.
 - 2. Structural Ties.
 - 3. Suspension Cables.
 - 4. Tension Elements.
- C. Stainless steel fabric structure wire rope assemblies including.
 - 1. Membrane Structures.
 - 2. Shade Structures.
 - 3. Lightweight Roofing.
- D. Stainless steel structural support rod assemblies including.
 - 1. Suspension Rods.
 - 2. Tension Elements.
 - 3. Structural Ties.
 - 4. Support rods.
- E. Stainless steel signage wire rope assemblies.
- F. Stainless steel suspended shelving wire rope assemblies.
- G. Stainless steel protective barrier netting wire rope assemblies.

2.3 WALL MOUNTING SPACERS/BRACKETS

- A. Provide wall mounting spacers, brackets and fittings required for attachment and connection to the structure and for support of stainless steel wire rope, wire netting, and metal rod as

indicated on the Drawings.

- B. Spacer Clearance and Load:
1. Wall Clearance: _____ inches.
 2. Design Lateral Force: _____ pounds (_____ kN). percent of wire rope minimum breaking strength.
 3. As selected by manufacture to suit application and design requirements specified.
- C. Mounting Types: Fabricate from AISI Type 316 and 316L stainless steel complying with ASTM F 1145; INOX Line anchors as manufactured by Jakob, Inc. Provide sizes and types as required to meet project design conditions specified and indicated on Drawings including:
1. Through Hole in Wood: Headless screw with nut and check nut on the back and a ring nut with support washer on the front.
 2. Screw-In Nut for Wood: Internal threaded device that accepts the threaded rope holder or headless screw device.
 3. Perforated Hollow Wall Anchor: Masonry or concrete anchor set with two-component adhesive with internal threads to accept threaded rope holder or headless screw device.
 4. Bolt Anchor with Internal Thread: Expansion bolt for concrete with internal threads to accept threaded wall fittings.
 5. Externally Insulated Facades: Expansion bolt for concrete with insulated support tube spacers and internal threads to accept externally threaded wall fittings.
 6. Shop applied swaged rope ends: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
- D. Stainless Steel Bars and Shapes: Type 316 stainless steel conforming to ASTM A 276. Provide sizes and shapes as required to meet project design conditions specified and indicated on Drawings.

2.4 WIRE ROPE

- A. Material: ASTM A 492 and ASTM A 555, Type 316 stainless steel. Fabricate wire rope with integral colored filament designating specific manufacturer.
- B. Type 1: __ x __ wire rope; INOX No. _____ as manufactured by Jakob, Inc.
1. Diameter: _____ inches (_____ mm).
 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- C. Type 2: __ x __ wire rope; INOX No. _____ as manufactured by Jakob, Inc.
1. Diameter: _____ inches (_____ mm).
 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- D. Type 3: __ x __ wire rope; INOX No. _____ as manufactured by Jakob, Inc.
1. Diameter: _____ inches (_____ mm).
 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- E. Length: Provide wire rope tendons in lengths indicated on Drawings and approved shop drawings.
1. Provide optimum adjustment in both directions by calculating final tendon lengths with allowance for tensioning fittings with 2/3 open and with 1/3 of thread length engaged.
 2. Measure tendon length from center of pin to center of pin, or center of eye to center of eye.

2.5 WIRE NETTING

- A. Material: Webnet as manufactured by Jakob, Inc. Parallel stainless steel wire ropes

connected by reciprocally curved offset sleeves or clamps such that ropes are neither knotted nor crossed. Wire rope shall be fabricated from cold-drawn, AISI Type 316 stainless steel wire complying with ASTM A 492 and ASTM A 555.

- B. Type 1: Webnet No. _____ as manufactured by Jakob, Inc.
 - 1. Diameter: _____ inches (_____ mm).
 - 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- C. Type 2: Webnet No. _____ as manufactured by Jakob, Inc.
 - 1. Diameter: _____ inches (_____ mm).
 - 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- D. Type 3: Webnet No. _____ as manufactured by Jakob, Inc.
 - 1. Diameter: _____ inches (_____ mm).
 - 2. Breaking load including safety factor: _____ pounds (_____ kg) minimum.
- E. Perimeter configurations:
 - 1. Perimeter Type No. _____ as manufactured by Jakob, Inc.
 - a. Open.
 - b. Closed with uncompressed sleeves.
 - c. Closed with eye ends.
 - d. Suitable for:
 - 1) Vertical installation.
 - 2) Horizontal installation.
 - 2. Perimeter Type No. _____ as manufactured by Jakob, Inc.
 - a. Open.
 - b. Closed with uncompressed sleeves.
 - c. Closed with eye ends.
 - d. Suitable for:
 - 1) Vertical installation.
 - 2) Horizontal installation.

2.6 STAINLESS STEEL RODS

- A. Rod spindles: Solid stainless steel rods, AISI Type 316 complying with ASTM A 276.
- B. Size:
 - 1. Diameter: 1/4 inch (6 mm).
 - 2. Diameter: 5/16 inch (8 mm).
 - 3. Diameter: 3/8 inch (10 mm).
 - 4. Diameter: 15/32 inch (12 mm).
 - 5. Diameter: 5/8 inch (16 mm).
 - 6. Diameter: 25/32 inch (20 mm).
 - 7. Diameter: 7/8 inch (22 mm).
 - 8. Diameter: 15/16 inch (24 mm).
 - 9. Lengths as indicated on the Drawings.
- C. Rod termination:
 - 1. External threads for on-site attachment.
 - 2. Swaged with end connector fittings.

2.7 FITTINGS AND CONNECTORS

- A. Provide fittings and connectors required for wire rope assemblies and for attachment and connection of stainless steel wire rope, wire netting and metal rods to support framework and substrates.

- B. Fitting minimum breaking strength:
 1. _____ percent of wire rope minimum breaking strength.
 2. As selected by manufacturer to suit application and design requirements specified.
- C. Types: Fabricate from AISI Type 316 and 316L stainless steel complying with ASTM F 1145; INOX Line Fittings as manufactured by Jakob, Inc. Provide sizes and types as required to meet project design conditions specified and indicated on Drawings and reviewed shop drawings including:
 1. Shop applied swaged rope ends: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
 2. Screwed rope ends for on-site assembly: Threaded external and internal swivel ends, turnbuckles, tensioning screws, end stops, clevis ends, eye ends, loop ends, and end cones.
 3. Clamps: Ring clamps, cross clamps, wire rope clamping cones, and connecting wire rope clamps.
 4. Post fittings: Straight, angled, and spherical
 5. Anchoring systems: Studs, clevis, eye end, eye bolt, slotted, spacer baskets, radial clevis holder, cross clamp with support disk, slotted rope deflector, ball cage.
- D. Accessories: Provide threaded couplings, tensioning screws, cover disks, eye bolts, eye nuts, carabineers, shackles, clips, welded rings, screws, washers, lock nuts, hexagonal nuts, dome nuts, wall anchors, screws, and wire end caps as required to complete the installation.

2.8 FINISH

- A. After fabrication, clean and de-scale stainless steel wire rope, fittings, and other components in accordance with ASTM A 380.
- B. Finish components with AISI No. 4 brushed satin finish in accordance with ASTM B 912.

2.9 FABRICATION

- A. Tolerances: Verify dimensions on site prior to shop fabrication.
- B. Fabricate stainless steel in accordance with AISI Steel Product Manual and the manufacturers requirements.
- C. Shop fabricate to designs indicated on Drawings and to meet performance requirements specified.
- D. Shop fabricate fittings, interfacing parts and assemblies so that field cutting adjustments are not necessary.
- E. Coordinate requirements, dimensions and spacing of wire rope assemblies to ensure required factory drilled holes in supporting framework are correctly located.
- F. Make exposed joints butt, flush, and hairline.
- G. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Before beginning installation, verify that conditions installed under other sections are acceptable for installation of cable trellis systems in accordance with manufacturer's

installation instructions.

- B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate Sections.
- C. Verify supporting system for stainless steel wire rope assemblies is prepared for attachment of anchors, fittings, wire rope, and wire netting and transfer of calculated loads.
- D. If conditions are the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Verify alignment, support dimensions, and tolerances are correct.
- B. Inventory components to ensure all required items are available for installation. Inspect components for damage. Remove damaged components from site and replace.
- C. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing.

3.3 INSTALLATION

- A. Install wire rope assemblies in accordance with manufacturer's instructions and the approved shop drawings.
- B. Provide anchorage devices and fittings to secure to in-place construction; including threaded fittings for concrete inserts, toggle bolts and through-bolts.
- C. Install components plumb, level, square, and rigid without kinks or sags.
- D. Anchor to mounting surfaces as indicated on the Drawings.
- E. Separate dissimilar materials with bushings, grommets or washers to prevent electrolytic corrosion.
- F. Use only manufacturer's supplied cable hardware.
- G. Ensure cables are clean, parallel to each other, and without kinks or sags.
- H. Tension cable with hand or hydraulic equipment so that no slack is visible.
- I. After final adjustment provide tamper resistant locktight materials on all fittings.

3.4 ADJUSTING AND CLEANING

- A. Adjust wire rope tension and connecting hardware.
- B. Remove temporary coverings and protection of adjacent work areas. Clean installed products in accordance with manufacturer's instructions before owner's acceptance.
- C. Do not use abrasive cleaners.
- D. Remove from project site and legally dispose of construction debris associated with this work.

3.5 PROTECTION

- A. Protect installed products until completion of project.

- B. Touch-up, repair or replace damaged products before Substantial Completion.
- C. Protect installed products and finished surfaces from damage during construction.
- D. Replace defective or damaged components as directed by Architect.

END OF SECTION

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.
- B. Items specified.
 - 1. Support for Wall and Ceiling Mounted Items: (SD055000-01, SD055000-02, SD102113-01, SD102600-01, SD123100-01 & SD123100-02)
 - 2. Frames:
 - 3. Guards
 - 4. Covers and Frames for Pits and Trenches.
 - 5. Gratings
 - 6. Loose Lintels
 - 7. Shelf Angles
 - 8. Gas Racks
 - 9. Plate Door Sill
 - 10. Safety Nosings
 - 11. Ladders
 - 12. Railings:
 - 13. Catwalks and Platforms
 - 14. Trap Doors with Ceiling Hatch
 - 15. Sidewalk Access Doors
 - 16. Screened Access Doors
 - 17. Steel Counter or Bench Top Frame and Leg
 - 18. Steel Pipe Bollards

1.2 RELATED WORK

- A. Railings attached to steel stairs: Section 05 51 00, METAL STAIRS.
- B. Colors, finishes, and textures: Section 09 06 00, SCHEDULE FOR FINISHES.
- C. Prime and finish painting: Section 09 91 00, PAINTING.
- D. Stainless steel corner guards: Section 10 26 00, WALL AND DOOR PROTECTION.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:

Grating, each type	Floor plate
Trap door	Wheel guards
Ceiling hatch	Sidewalk Access door
Manhole Covers	Safety nosing

- C. Shop Drawings:

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

- D. Manufacturer's Certificates:

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

- E. Design Calculations for specified live loads including dead loads.

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

1.4 QUALITY ASSURANCE

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

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
- B18.6.1-97Wood Screws
- B18.2.2-87(R2010)Square and Hex Nuts
- C. American Society for Testing and Materials (ASTM):
- A36/A36M-14Structural Steel
- A47-99(R2014)Malleable Iron Castings
- A48-03(R2012)Gray Iron Castings
- A53-12Pipe, Steel, Black and Hot-Dipped, Zinc-Coated
Welded and Seamless
- A123-15Zinc (Hot-Dip Galvanized) Coatings on Iron and
Steel Products
- A240/A240M-15Standard Specification for Chromium and
Chromium-Nickel Stainless Steel Plate, Sheet
and Strip for Pressure Vessels and for General
Applications.
- A269-15Seamless and Welded Austenitic Stainless Steel
Tubing for General Service
- A307-14Carbon Steel Bolts and Studs, 60,000 PSI
Tensile Strength
- A391/A391M-07(R2015) ...Grade 80 Alloy Steel Chain
- A786/A786M-15Rolled Steel Floor Plate
- B221-14Aluminum and Aluminum-Alloy Extruded Bars,
Rods, Wire, Shapes, and Tubes
- B456-11Electrodeposited Coatings of Copper Plus Nickel
Plus Chromium and Nickel Plus Chromium
- B632-08Aluminum-Alloy Rolled Tread Plate
- C1107-13Packaged Dry, Hydraulic-Cement Grout (Non-
shrink)
- D3656-13Insect Screening and Louver Cloth Woven from
Vinyl-Coated Glass Yarns
- F436-16Hardened Steel Washers

- F468-06(R2015)Nonferrous Bolts, Hex Cap Screws, Socket Head
Cap Screws and Studs for General Use
- F593-13Stainless Steel Bolts, Hex Cap Screws, and
Studs
- F1667-15Driven Fasteners: Nails, Spikes and Staples
- D. American Welding Society (AWS):
- D1.1-15Structural Welding Code Steel
- D1.2-14Structural Welding Code Aluminum
- D1.3-18Structural Welding Code Sheet Steel
- E. National Association of Architectural Metal Manufacturers (NAAMM)
- AMP 521-01(R2012)Pipe Railing Manual
- AMP 500-06Metal Finishes Manual
- MBG 531-09(R2017)Metal Bar Grating Manual
- MBG 532-09Heavy Duty Metal Bar Grating Manual
- F. Structural Steel Painting Council (SSPC)/Society of Protective
Coatings:
- SP 1-15No. 1, Solvent Cleaning
- SP 2-04No. 2, Hand Tool Cleaning
- SP 3-04No. 3, Power Tool Cleaning
- G. Federal Specifications (Fed. Spec):
- RR-T-650ETreads, Metallic and Nonmetallic, Nonskid

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- A. In addition to the dead loads, design fabrications to support the following live loads unless otherwise specified.
- B. Ladders and Rungs: 120 kg (250 pounds) at any point.
- C. Railings and Handrails: 900 N (200 pounds) in any direction at any point.
- D. Floor Plates, Gratings, Covers, Trap Doors, Catwalks, and Platforms: 40 pounds per square foot. Use 300poundsfor concentrated loads.
- E. Manhole Covers: 1200 kg/m² (250 pounds per square foot).

2.2 MATERIALS

- A. Structural Steel: ASTM A36.
- B. Stainless Steel: ASTM A240, Type 302 or 304.

- C. Aluminum, Extruded: ASTM B221, Alloy 6063-T5 unless otherwise specified. For structural shapes use alloy 6061-T6 and alloy 6061-T4511.
- D. Floor Plate:
 - 1. Steel ASTM A786.
 - 2. Aluminum: ASTM B632.
- E. Steel Pipe (Bollard): ASTM A53.
 - 1. Galvanized for exterior locations.
 - 2. Type S, Grade A unless specified otherwise.
 - 3. NPS (inside diameter) as shown.
- F. Cast-Iron: ASTM A48, Class 30, commercial pattern.
- G. Malleable Iron Castings: A47.
- H. Primer Paint: As specified in Section 09 91 00, PAINTING.
- I. Stainless Steel Tubing: ASTM A269, type 302 or 304.
- J. Modular Channel Units:
 - 1. Factory fabricated, channel shaped, cold formed sheet steel shapes, complete with fittings bolts and nuts required for assembly.
 - 2. Form channel within turned pyramid shaped clamping ridges on each side.
 - 3. Provide case hardened steel nuts with serrated grooves in the top edges designed to be inserted in the channel at any point and be given a quarter turn so as to engage the channel clamping ridges. Provide each nut with a spring designed to hold the nut in place.
 - 4. Factory finish channels and parts with oven baked primer when exposed to view. Channels fabricated of ASTM A525, G90 galvanized steel may have primer omitted in concealed locations. Finish screws and nuts with zinc coating.
 - 5. Fabricate snap-in closure plates to fit and close exposed channel openings of not more than 0.3 mm (0.0125 inch) thick stainless steel.
- K. Grout: ASTM C1107, pourable type.
- L. Insect Screening: ASTM D3656.

2.3 HARDWARE

- A. Rough Hardware:
 - 1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated,

or zinc-coated by electro-galvanizing process. Galvanized G-90 where specified.

2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

B. Fasteners:

1. Bolts with Nuts:

- a. ASME B18.2.2.
- b. ASTM A307 for 415 MPa (60,000 psi) tensile strength bolts.
- c. ASTM F468 for nonferrous bolts.
- d. ASTM F593 for stainless steel.

2. Screws: ASME B18.6.1.

3. Washers: ASTM F436, type to suit material and anchorage.

4. Nails: ASTM F1667, Type I, style 6 or 14 for finish work.

2.4 FABRICATION GENERAL

A. Material

1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.
2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

C. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
4. Holes, for rivets and bolts: Accurately punched or drilled and burrs removed.

5. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
6. Use Rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
7. Use stainless steel connectors for removable members machine screws or bolts.

D. Fasteners and Anchors

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.
2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self-drilling and tapping screws or bolts.

E. Workmanship

1. General:
 - a. Fabricate items to design shown.
 - b. Furnish members in longest lengths commercially available within the limits shown and specified.
 - c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
 - d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.

- e. Provide openings, cut-outs, and tapped holes for attachment and clearances required for work of other trades.
 - f. Prepare members for the installation and fitting of hardware.
 - g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.
 - h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.
2. Welding:
- a. Weld in accordance with AWS.
 - b. Welds shall show good fusion, be free from cracks and porosity and accomplish secure and rigid joints in proper alignment.
 - c. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
 - d. Finish welded joints to match finish of adjacent surface.
3. Joining:
- a. Miter or butt members at corners.
 - b. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.
4. Anchors:
- a. Where metal fabrications are shown to be preset in concrete, weld 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 150 mm (6 inches) long with 25 mm (one inch) hooked end, to back of member at 600 mm (2 feet) on center, unless otherwise shown.
 - b. Where metal fabrications are shown to be built into masonry use 32 x 3 mm (1-1/4 by 1/8 inch) steel strap anchors, 250 mm (10 inches) long with 50 mm (2 inch) hooked end, welded to back of member at 600 mm (2 feet) on center, unless otherwise shown.
5. Cutting and Fitting:
- a. Accurately cut, machine and fit joints, corners, copes, and miters.
 - b. Fit removable members to be easily removed.
 - c. Design and construct field connections in the most practical place for appearance and ease of installation.

- d. Fit pieces together as required.
 - e. Fabricate connections for ease of assembly and disassembly without use of special tools.
 - f. Joints firm when assembled.
 - g. Conceal joining, fitting and welding on exposed work as far as practical.
 - h. Do not show rivets and screws prominently on the exposed face.
 - i. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.
- F. Finish:
- 1. Finish exposed surfaces in accordance with NAAMM AMP 500 Metal Finishes Manual.
 - 2. Aluminum: NAAMM AMP 501.
 - a. Mill finish, AA-M10, as fabricated, use unless specified otherwise.
 - b. Clear anodic coating, AA-C22A41, chemically etched medium matte, with Architectural Class 1, 0.7 mils or thicker.
 - c. Colored anodic coating, AA-C22A42, chemically etched medium matte with Architectural Class 1, 0.7 mils or thicker.
 - d. Painted: AA-C22R10.
 - 3. Steel and Iron: NAAMM AMP 504.
 - a. Zinc coated (Galvanized): ASTM A123, G90 unless noted otherwise.
 - b. Surfaces exposed in the finished work:
 - 1) Finish smooth rough surfaces and remove projections.
 - 2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.
 - c. Shop Prime Painting:
 - 1) Surfaces of Ferrous metal:
 - a) Items not specified to have other coatings.
 - b) Galvanized surfaces specified to have prime paint.
 - c) Remove all loose mill scale, rust, and paint, by hand or power tool cleaning as defined in SSPC-SP2 and SP3.

d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP1.

e) After cleaning and finishing apply one coat of primer as specified in Section 09 91 00, PAINTING.

2) Nonferrous metals: Comply with MAAMM-500 series.

4. Stainless Steel: NAAMM AMP-504 Finish No. 4.

5. Chromium Plating: ASTM B456, satin or bright as specified, Service Condition No. SC2.

G. Protection:

1. Insulate aluminum surfaces that will come in contact with concrete, masonry, plaster, or metals other than stainless steel, zinc or white bronze by giving a coat of heavy-bodied alkali resisting bituminous paint or other approved paint in shop.

2. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal, using zinc rich paint on hot-dip zinc coat items and zinc dust primer on all other zinc coated items.

2.5 SUPPORTS

A. General:

1. Fabricate ASTM A36 structural steel shapes as shown.

2. Use clip angles or make provisions for welding hangers and braces to overhead construction.

3. Field connections may be welded or bolted.

B. For Ceiling Hung Toilet Stall:

1. Use a continuous steel channel above pilasters with hangers centered over pilasters.

2. Make provision for installation of stud bolts in lower flange of channel.

3. Provide a continuous steel angle at wall and channel braces spaced as shown.

4. Use threaded rod hangers.

5. Provide diagonal angle brace where the suspended ceiling over toilet stalls does not extend to side wall of room.

C. For Wall Mounted Items:

1. For items supported by metal stud partitions.

2. Steel strip or hat channel minimum of 1.5 mm (0.0598 inch) thick.

3. Steel strip minimum of 150 mm (6 inches) wide, length extending one stud space beyond end of item supported.
4. Steel hat channels where shown. Flange cut and flatted for anchorage to stud.
5. Structural steel tube or channel for grab bar at water closets floor to structure above with clip angles or end plates formed for anchors.
6. Use steel angles for thru wall counters. Drill angle for fasteners at ends and not over 100 mm (4 inches) on center between ends.

D. For Trapeze Bars:

1. Construct assembly above ceilings as shown and design to support not less than a 340 kg (750 pound) working load at any point.
2. Fabricate trapeze supports as shown, with all exposed members, including screws, nuts, bolts and washers, fabricated of stainless steel.
3. Fabricate concealed components of structural steel shapes unless shown otherwise.
4. Stainless steel ceiling plate drilled for eye bolt.
5. Continuously weld connections where welds shown.
6. Use modular channel where shown with manufacturers bolts and fittings.
 - a. Weld ends of steel angle braces to steel plates and secure to modular channel units as shown. Drill plates for anchor bolts.
 - b. Fabricate eye bolt, special clamp bolt, and plate closure full length of modular channel at ceiling line and secure to modular channel unit with manufacturers standard fittings.

E. For Intravenous Track and Cubical Curtain Track:

1. Fabricate assembly of steel angle as shown.
2. Drill angle bent ends for anchor screws to acoustical suspension system and angle for hanger wires.
3. Provide pipe sleeve welded to angle.

F. Supports at Ceiling for Radiographic (x-ray) Equipment:

1. Fabricate hangers, braces, and track of modular channel units assembly as shown.
2. Fabricate steel plates for anchor to structure above.
3. Drill bent plates for bolting at mid height at concrete beams.

- G. For Operating Room Light:
1. Fabricate as shown to suit equipment furnished.
 2. Drill leveling plate for light fixture bolts.
- H. Supports in Orthopedic Brace Shop:
1. Fabricate from 25 mm (one inch) steel pipe, fasten to steel angles above and extend to a point 150 mm (6 inches) below finished ceiling.
 2. Lower end of the pipe shall have a standard pipe thread.
 3. Provide an escutcheon plate at ceiling.
- I. Supports for Accordion Partition Tracks, Exercise Equipment, and Items at Various Conditions at Suspended Ceilings:
1. Fabricate of structural steel shapes as shown.
 2. Drill for anchor bolts of suspended item.
- J. Supports for Communion Rail Posts in Chapel:
1. Fabricate one steel plate support for each post as shown.
 2. Drill for fasteners.

2.6 FRAMES

- A. Elevator Entrance Wall Opening.
1. Fabricate of channel shapes, plates, and angles as shown.
 2. Weld or bolt head to jamb as shown.
 3. Weld clip angles to bottom of frame and top of jamb members extended to structure above for framed construction.
 - a. Provide holes for anchors.
 - b. Weld head to jamb members.
- B. Channel Door Frames:
1. Fabricate of structural steel channels of size shown.
 2. Miter and weld frames at corners.
 3. Where anchored to masonry or embedded in concrete, weld to back of frame at each jamb, 5 mm (3/16 inch) thick by 44 mm (1-3/4 inch) wide steel strap anchors with ends turned 50 mm (2 inches), and of sufficient length to extend at least 300 mm (12 inches) into wall. Space anchors 600 mm (24 inches) above bottom of frame and 600 mm (24 inches) o.c. to top of jamb. Weld clip angles to bottom of jambs and provide holes for expansion bolts.
 4. Where anchored to concrete or masonry in prepared openings, drill holes at jambs for anchoring with expansion bolts. Weld clip angles

to bottom of frame and provide holes for expansion bolt anchors as shown. Drill holes starting 600 mm (24 inches) above bottom of frame and 600 mm (24 inches) o.c. to top of jamb and at top of jamb. Provide pipe spacers at holes welded to channel.

5. Where closure plates are shown, continuously weld them to the channel flanges.
6. Weld continuous 19 x 19 x 3 mm (3/4 x 3/4 x 1/8 inch) thick steel angles to the interior side of each channel leg at the head and jambs to form a caulking groove.
7. Prepare frame for installation of hardware specified in Section 08 71 00, DOOR HARDWARE.
 - a. Cut a slot in the lock jamb to receive the lock bolt.
 - b. Where shown use continuous solid steel bar stops at perimeter of frame, weld or secure with countersunk machine screws at not more than 450 mm (18 inches) on center.

C. Frames for Breech Opening:

1. Fabricate from steel channels, or combination of steel plates and angles to size and contour shown.
2. Weld strap anchors on back of frame at not over 600 mm (2 feet) on centers for concrete or masonry openings.

D. Frames for Lead Lined Doors:

1. Obtain accurate dimensions and templates from suppliers of lead lined doors, finish hardware, and hollow steel door frames.
2. Fabricate as shown for use in connection with lead lined doors.
3. Deliver assembled frames with removable shipping spreaders at top and bottom.
4. Extend angles at jambs from floor to structural slab above. At floors of interstitial spaces, terminate jamb sections and provide anchors as shown.
5. Continuously weld plates and reinforcements to frame members and head members of angle frames between jambs.
6. Weld strap anchors, not over 600 mm (24 inches) on centers, to the back of angles for embedment in masonry or concrete unless shown otherwise.

7. Type 15 Door Frames:

- a. Structural steel angle frames with plate or bar full height to heads. Extend reinforcing at hinge cutouts two inches beyond cutout.
- b. Fabricate top anchorage to beam side at mid height.
- c. Weld clip angles to both legs of angle at top and bottom.
- d. Drill clips and plates, at top and bottom for anchoring jamb angles with two 9 mm (3/8 inch) expansion bolts at each location.
- e. Cut rabbet for pivot hinges and lock strike.

2.7 GUARDS

A. Wall Corner Guards:

1. Fabricate from steel angles and furnish with anchors as shown.
2. Continuously weld anchor to angle.

B. Guard Angles for Overhead Doors:

1. Cut away top portion of outstanding leg of angle and extend remaining portion of angle up wall.
2. Weld filler piece across head of opening to jamb angles.
3. Make provisions for fasteners and anchorage.

C. Channel Guard at Loading Platform:

1. Fabricate from steel channel of size shown.
2. Weld anchors to channels as shown.
3. Drill channel for bumper anchor bolts.

D. Edge Guard Angles for Openings in slabs.

1. Fabricate from steel angles of sizes and with anchorage shown.
2. Where size of angle is not shown, provide 50 x 50 x 6 mm (2 x 2 x 1/4 inch) steel angle with 32 x 5 mm (1-1/4 x 3/16 inch) strap anchors, welded to back.
3. Miter or butt angles at corners and weld.
4. Use one anchor near end and three feet on centers between end anchors.

E. Wheel Guards:

1. Construct wheel guards of not less than 16 mm (5/8 inch) thick cast iron.
2. Provide corner type, with flanges for bolting to walls.

2.8 COVERS AND FRAMES FOR PITS AND TRENCHES

- A. Fabricate covers to support live loads specified.

- B. Galvanized steel members after fabrication in accordance with ASTM A123, G-90 coating.
- C. Steel Covers:
1. Use 6 mm (1/4 inch) thick floor plate for covers unless otherwise shown. Use gratings where shown as specified in paragraph GRATINGS. Use smooth floor plate unless noted otherwise.
 2. Provide clearance at all sides to permit easy removal of covers.
 3. Make cutouts within 6 mm (1/4 inch) of penetration for passage of pipes and ducts.
 4. Drill covers for flat head countersunk screws.
 5. Make cover sections not to exceed 2.3 m² (25 square feet) in area and 90 kg (200 pounds) in weight.
 6. Fabricate trench cover sections to not be over 900 mm (3 feet) long and if width of trench is more than 900 mm (3 feet) or over, equip one end of each section with an angle or "T" bar stiffener to support adjoining plate.
 7. Use two, 13 mm (1/2 inch) diameter steel bar flush drop handles for each cover section.
- D. Cast Iron Covers
1. Fabricate covers to support live loads specified.
 2. Fabricate from ASTM A48, cast-iron, 13 mm (1/2 inch) minimum metal thickness, cast with stiffeners as required.
 3. Fabricate as flush type with frame, reasonably watertight and be equipped with flush type lifting rings. Provide seals where watertight covers noted.
 4. Make covers in sections not over 90 kg (200 pounds) except round covers.
- E. Steel Frames:
1. Form frame from structural steel angles as shown. Where not shown use 63 x 63 x 6 mm (2-1/2 x 2-1/2 x 1/4 inch) angles for frame openings over 1200 mm (4 feet) long and 50 x 50 x 6 mm (2 ix 2 x 1/4 inch) for frame openings less than 1200 mm (4 feet).
 2. Fabricate intermediate supporting members from steel "T's" or angles; located to support cover section edges.
 3. Where covers are required use steel border bars at frames so that top of cover will be flush with frame and finish floor.

4. Weld steel strap anchors to frame. Space straps not over 600 mm (24 inches) o.c., not shown otherwise between end anchors. Use 6 x 25 x 200 mm (1/4 x 1 x 8 inches) with 50 mm (2 inch) bent ends strap anchors unless shown otherwise.

5. Drill and tap frames for screw anchors where plate covers occur.

F. Cast Iron Frames:

1. Fabricate from ASTM A48 cast iron to shape shown.
2. Provide anchors for embedding in concrete, spaced near ends and not over 600 mm (24 inches) apart.

2.9 GRATINGS

A. Fabricate gratings to support live loads specified and a concentrated load as specified.

B. Provide clearance at all sides to permit easy removal of grating.

C. Make cutouts in gratings with 6 mm (1/4 inch) minimum to 25 mm (one inch) maximum clearance for penetrations or passage of pipes and ducts. Edge band cutouts.

D. Fabricate in sections not to exceed 2.3 m² (25 square feet) in area and 90 kg (200 pounds) in weight.

E. Fabricate sections of grating with end-banding bars.

F. Fabricate angle frames and supports, including anchorage as shown.

1. Fabricate intermediate supporting members from "T's" or angles.
2. Locate intermediate supports to support grating section edges.
3. Fabricate frame to finish flush with top of grating.
4. Locate anchors at ends and not over 600 mm (24 inches) o.c.
5. Butt or miter, and weld angle frame at corners.

G. Steel Bar Gratings:

1. Fabricate grating using steel bars, frames, supports and other members shown in accordance with Metal Bar Grating Manual.
2. Galvanize steel members after fabrication in accordance with ASTM A123, G-90 for exterior gratings, gratings in concrete floors, and interior grating where specified.
3. Interior gratings: Prime paint unless specified galvanized.

H. Aluminum Bar Gratings:

1. Fabricate grating and frame assembly from aluminum as shown in accordance with Metal Bar Grating Manual.
2. Use 25 x 5 mm (1 x 3/16 inch) minimum size bearing bars.

3. Mill finish unless specified otherwise.

I. Plank Gratings:

1. Conform to Fed. Spec. RR-G-1602.
2. Manufacturers standard widths, lengths and side channels to meet live load requirements.
3. Galvanize exterior steel gratings ASTM A123, G-90 after fabrication.
4. Fabricate interior steel gratings from galvanized steel sheet, ASTM A525, where bearing on concrete or masonry.
5. Fabricate other interior grating from steel sheet and finish with shop prime paint. Prime painted galvanized sheet may be used.

J. Cast Iron Gratings:

1. Fabricate gratings to support a live load of 23940 Pa (500 pounds per square foot).
2. Fabricate gratings and frames for gutter type drains from cast-iron conforming to ASTM A48.
3. Fabricate gratings in section not longer than 1200 mm (4 feet) or over 90 kg (200 pounds) and fit so as to be readily removable.

2.10 LOOSE LINTELS

- A. Furnish lintels of sizes shown. Where size of lintels is not shown, provide the sizes specified.
- B. Fabricate lintels with not less than 150 mm (6 inch) bearing at each end for nonbearing masonry walls, and 200 mm (8 inch) bearing at each end for bearing walls.
- C. Provide one angle lintel for each 100 mm (4 inches) of masonry thickness as follows except as otherwise specified or shown.
 1. Openings 750 mm to 1800 mm (2-1/2 feet to 6 feet) - 100 x 90 x 8 mm (4 x 3-1/2 x 5/16 inch).
 2. Openings 1800 mm to 3000 mm (6 feet to 10 feet) - 150 x 90 x 9 mm (6 x 3-1/2 x 3/8 inch).
- D. For 150 mm (6 inch) thick masonry openings 750 mm to 3000 mm (2-1/2 feet to 10 feet) use one angle 150 x 90 x 9 mm (6 x 3-1/2 x 3/8 inch).
- E. Provide bearing plates for lintels where shown.
- F. Weld or bolt upstanding legs of double angle lintels together with 19 mm (3/4 inch bolts) spaced at 300 mm (12 inches) on centers.
- G. Insert spreaders at bolt points to separate the angles for insertion of metal windows, louver, and other anchorage.

H. Where shown or specified, punch upstanding legs of single lintels to suit size and spacing of anchor bolts.

I. Elevator Entrance:

1. Fabricate lintel from plate bent to channel shape and provide a minimum of 100 mm (4 inch) bearing each end.
2. Cut away the front leg of the channel at each end to allow for concealment behind elevator hoistway entrance frame.

2.11 SHELF ANGLES

- A. Fabricate from steel angles of size shown.
- B. Fabricate angles with horizontal slotted holes for 19 mm (3/4 inch) bolts spaced at not over 900 mm (3 feet) on centers and within 300 mm (12 inches) of ends.
- C. Provide adjustable malleable iron inserts for embedded in concrete framing.

2.12 PLATE DOOR SILL

- A. Fabricate of checkered plate as detailed.
 1. Aluminum Plate: ASTM B632, 3 mm (0.125 inch) thick.
 2. Steel Plate: ASTM A786, 3 mm (0.125 inch thick), galvanized G90.
- B. Fabricate for anchorage with flat head countersunk bolts at each end and not over 300 mm (12 inches), o.c.

2.13 SAFETY NOSINGS

- A. Fed. Spec. RR-T-650, Type C.
 1. Aluminum: Class 2, Style 2.
 2. Cast iron: Class 4.
- B. Fabricate nosings for exterior use from cast aluminum, and nosings for interior use from either cast aluminum or cast iron. Use one Class throughout.
- C. Fabricate nosings approximately 100 mm (4 inches) wide with not more than 9 mm (3/8 inch) nose.
- D. Provide nosings with integral type anchors spaced not more than 100 mm (4 inches) from each end and intermediate anchors spaced approximately 375 mm (15 inches) on center.
- E. Fabricate nosings to extend within 100 mm (4 inches) of ends of concrete stair treads except where shown to extend full width.
- F. Fabricate nosings to extend full width between stringers of metal stairs and full width of door openings.

- G. On curved steps fabricate to terminate at point of curvature of steps having short radius curved ends.

2.14 LADDERS

A. Steel Ladders:

1. Fixed-rail type with steel rungs shouldered and headed into and welded to rails.
2. Fabricate angle brackets of 50 mm (2 inch) wide by 13 mm (1/2 inch) thick steel; brackets spaced maximum of 1200 mm (4 feet) apart and of length to hold ladder 175 mm (7 inches) from wall to center of rungs. Provide turned ends or clips for anchoring.
3. Provide holes for anchoring with expansion bolts through turned ends and brackets.
4. Where shown, fabricate side rails curved, twisted and formed into a gooseneck.
5. Galvanize exterior ladders after fabrication, ASTM A123, G-90.

B. Aluminum Ladders:

1. Fixed-rail type, constructed of structural aluminum, with mill finish.
2. Fabricate side rails and rungs of size and design shown, with the rungs shouldered and headed into and welded to the rails.
3. Where shown fabrication side rails curved, twisted and formed into gooseneck.
4. Fabricate angle brackets at top and bottom and intermediate brackets where shown. Drill for bolting.

C. Ladder Rungs:

1. Fabricate from 25 mm (one inch) diameter steel bars.
2. Fabricate so that rungs will extend at least 100 mm (4 inches) into wall with ends turned 50 mm (2 inches), project out from wall 175 mm (7 inches), be 400 mm (16 inches) wide and be designed so that foot cannot slide off end.
3. Galvanized after fabrication, ASTM A123, G-90 rungs for exterior use and for access to pits.

2.15 RAILINGS

- A. In addition to the dead load design railing assembly to support live load specified.

B. Fabrication General:

1. Provide continuous welded joints, dressed smooth and flush.
 2. Standard flush fittings, designed to be welded, may be used.
 3. Exposed threads will not be approved.
 4. Form handrail brackets to size and design shown.
 5. Exterior Post Anchors.
 - a. Fabricate tube or pipe sleeves with closed ends or plates as shown.
 - b. Where inserts interfere with reinforcing bars, provide flanged fittings welded or threaded to posts for securing to concrete with expansion bolts.
 - c. Provide heavy pattern sliding flange base plate with set screws at base of pipe or tube posts.
 6. Interior Post Anchors:
 - a. Provide flanged fittings for securing fixed posts to floor with expansion bolts, unless shown otherwise.
 - b. Weld or thread flanged fitting to posts at base.
 - c. For securing removable posts to floor, provide close fitting sleeve insert or inverted flange base plate with stud bolts or rivets concrete anchor welded to the base plate.
 - d. Provide sliding flange base plate on posts secured with set screws.
 - e. Weld flange base plate to removable posts set in sleeves.
- C. Handrails:
1. Close free ends of rail with flush metal caps welded in place except where flanges for securing to walls with bolts are shown.
 2. Make provisions for attaching handrail brackets to wall, posts, and handrail as shown.
- D. Steel Pipe Railings:
1. Fabricate of steel pipe with welded joints.
 2. Number and space of rails as shown.
 3. Space posts for railings not over 1800 mm (6 feet) on centers between end posts.
 4. Form handrail brackets from malleable iron.
 5. Fabricate removable sections with posts at end of section.
 6. Removable Rails:

- a. Provide "U" shape brackets at each end to hold removable rail as shown. Use for top and bottom horizontal rail when rails are joined together with vertical members.
 - b. Secure rail to brackets with 9 mm (3/8 inch) stainless steel through bolts and nuts at top rail only when rails joined with vertical members.
 - c. Continuously weld brackets to post.
 - d. Provide slotted bolt holes in rail bracket.
 - e. Weld bolt heads flush with top of rail.
 - f. Weld flanged fitting to post where posts are installed in sleeves.
7. Opening Guard Rails:
- a. Fabricate rails with flanged fitting at each end to fit between wall opening jambs.
 - b. Design flange fittings for fastening with machine screws to steel plate anchored to jambs.
 - c. Fabricate rails for floor openings for anchorage in sleeves.
8. Gates:
- a. Fabricate from steel pipe as specified for railings.
 - b. Fabricate gate fittings from either malleable iron or wrought steel.
 - c. Hang each gate on suitable spring hinges of clamp on or through bolted type. Use bronze hinges for exterior gates.
 - d. Provide suitable stops, so that gate will swing as shown.
9. Chains:
- a. Chains: ASTM A391, Grade 63, straight link style, normal size chain bar 8 mm (5/16 inch) diameter, eight links per 25 mm (foot) and with boat type snap hook on one end and through type eye bolt on the other end.
 - b. Fabricate eye bolt for attaching chain to pipe posts, size not less than 9 mm (3/8 inch) diameter.
 - c. Fabricate anchor at walls, for engagement of snap hook of either a 9 mm (3/8 inch) diameter eye bolt or punched angle.
 - d. Galvanize chain and bolts after fabrication.
- E. Aluminum Railings:
1. Fabricate from extruded aluminum.

2. Use tubular posts not less than 3 mm (0.125 inch) wall thickness for exterior railings.
3. Punch intermediate rails and bottom of top rails for passage of posts and machine to a close fit.
4. Where shown use extruded channel sections for top rail with 13 mm (1/2 inch) thick top cover plates and closed ends.
5. Fabricate brackets of extruded or wrought aluminum as shown.
6. Fabricate stainless pipe sleeves with closed bottom at least six inches deep having internal dimensions at least 13 mm (1/2 inch) greater than external dimensions of posts where set in concrete.

F. Stainless Steel Railings:

1. Fabricate from 38 mm (1-1/2 inches) outside diameter stainless steel tubing, ASTM A269, having a wall thickness of 1.6 mm (0.065 inch).
2. Join sections by an internal connector to form hairline joints where field assembled.
3. Fabricate with continuous welded connections.
4. Fabricate brackets of stainless steel to design shown.
5. Fabricate stainless steel sleeves at least 150 mm (6 inches) deep having internal dimensions at least 13 mm (1/2 inch) greater than external dimensions of post.

2.16 CATWALKS

- A. Fabricate catwalks including platforms, railings, ladders, supports and hangers, and arrangement of members as shown on drawings.
- B. Fabricate stairs as specified in Section 05 51 00, METAL STAIRS.
- C. Fabricate steel ladders as specified under paragraph LADDERS unless shown otherwise.
- D. Fabricate steel pipe railings as specified under paragraph RAILINGS.
- E. Catwalk and platforms floor surfaces as shown.
 1. Steel gratings as specified under paragraph gratings, either bar or plank type.
 2. Steel floor plate.
 3. Aluminum floor plate.
- F. Prime paint catwalk system.

2.17 TRAP DOOR AND FRAMES WITH CEILING HATCH

- A. Design to support a live load as specified.
- B. Frames:

1. Fabricate steel angle frame to set in concrete slabs and design to set flush with finished concrete slab or curb. If not shown use 63 x 63 x 6 mm (2-1/2 x 2-1/2 x 1/4 inch) angles.
2. Miter steel angles at corners and weld together.
3. Weld steel bar stops to vertical leg of frame, to support doors flush with the top of the frame.
4. Weld steel strap anchors on each side not over 600 mm (24 inches) on center to the backs of the frames. If not shown use 6 x 50 x 200 mm (1/4 x 2 x 8 inch) long straps with 50 mm (2 inch bent) ends.
5. Form frames from steel angles with welded corners for reinforcing and bracing of well lining and support of ceiling hatch.

C. Covers:

1. Use 6 mm (1/4 inch) thick steel floor plate.
2. Where double leaf covers are shown, reinforce at meeting edges.
3. Use wrought steel hinges with fixed brass pins.
 - a. Weld to cover.
 - b. Secure to frame with machine screws.
4. Where ladders occur, install hinges on the side opposite the ladder.
5. Provide two bar type drop handles, flush with cover when closed for each leaf.

D. Well Lining:

1. Fabricate well linings, for access through concrete floor slabs and suspended ceilings, from hatch to ceiling hatch or ceiling openings.
2. Use steel sheet and shapes of size and thickness as shown. If not shown use 1.5 mm (0.0598 inch) thick steel sheet.
3. If not shown use 50 x 50 x 6 mm (2 x 2 x 1/4 inch) angle braces from ceiling level on each side angled at 45 degrees to structure above.
4. Use 25 x 25 x 3 mm (1 x 1 x 1/8 inch) angle bottom flange trim welded to well lining where no ceiling hatch occurs.

E. Ceiling Hatch:

1. Construct hatch with "T" or angle frame designed to support edge of ceiling and hatch, weld to well lining.
2. Form hatch panels of 3 mm (1/8 inch) steel, 5 mm (3/16 inch) aluminum or 1 mm (0.0359 inch) thick steel of pan type construction with 25 mm (one inch) of mineral fiber insulation between.

3. Use counterbalance device, hinges, latch, hangers and other accessories required for installation and operation of hatch with not over 90 N (20 pounds) of force.
 4. Fabricate panels flush and reinforced to remain flat.
 5. Locate hatch panel flush with frame.
- F. Finish with baked on prime coat.

2.18 SIDEWALK DOOR

- A. Use flush, watertight, gutter type design.
- B. Cover fabricate of 6 mm (1/4 inch) thick, diamond pattern floor plate.
- C. Use automatic lock hold open feature and be hung on two flush type heavy bronze hinges capable of 90 degree swing on each door leaf.
- D. Equip with locking and latching device and lifting devices, operable and accessible from both sides of doors.
- E. Doors removable without disturbing frame.
- F. Provide gutters at all joints for drainage of water.

2.19 SCREENED ACCESS DOORS AND FRAMES

- A. Galvanized ASTM A123, G-90 after fabrication.
- B. Wall frame:
 1. Fabricate frame from steel angles or channels as shown.
 2. Continuously weld 38 x 13 mm (1-1/2 x 1/2 inch) steel channel door stop to angle frame. Cut out lock strike opening in channel.
 3. Miter and weld channel frame at corners. Reinforce corner with 3 mm (1/8 inch) plate angle.
 4. Reinforce channel frame with 3 x 150 mm (1/8 x 6 inch) long steel plate at channel back to cut out for latch. Cutout lock strike opening in channel face. Drill and tap for hinge anchorage.
 5. Drill jambs for 6 mm (1/4 inch) bolt anchors at top and bottom and not over 450 mm (18 inches) between top and bottom.
 6. Fabricate frame for door to sit flush with face of frame.
- C. Doors
 1. Fabricate door using steel channel frame with 3 mm (1/8 inch) angle plate reinforcing at corners.
 2. Miter and weld corners.
 3. Fabricate lock box of 1.6 mm (1/16 inch) plate and weld to channel surround.

4. Provide wire mesh constructed of 3.5 mm (0.135 inch) diameter galvanized steel wire crimped and woven into 38 mm (1-1/2 inch) diamond mesh pattern. Fasten the wire mesh to door frames by bending the ends of each strand of wire over through channel clinched and welded to channel door frame.
 5. Weld steel plate back-bands to channel door frame at hinge stiles only.
 6. Screen on doors in exterior walls.
 - a. Fabricate rewireable frame for screen from either extruded or tubular aluminum.
 - b. Design to allow for removing or replacement frame and screening or adjoining items without damage.
 - c. Use aluminum insect screening specified.
 - d. Use stainless steel fasteners for securing screen to door.
- D. Hardware:
1. Install hinged door to fixed frame with two 63 mm (2-1/2 inch) brass or bronze hinges.
 2. Install lock or latch specified in Section 08 71 00, DOOR HARDWARE in lockbox.

2.20 STEEL COUNTER OR BENCH TOP FRAME AND LEGS

- A. Fabricate channel or angle frame with mitered and welded corners as shown.
- B. Drill top of frame with 6 mm (1/4inch) holes spaced 200 mm (8 inches) on center for securing countertop.
- C. Fabricate legs of angle or pipe shapes and continuously weld to frame.
- D. Finish frame with backed on enamel prime coat.

2.21 STEEL PIPE BOLLARD

Provide bollard in accordance with ASTM A53 with dimensions as shown in standard detail SD320523-04. Anchor posts in concrete and fill solidly with concrete with a minimum compressive strength of 17 MPa 2500psi.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set work accurately, in alignment and where shown, plumb, level, free of rack and twist, and set parallel or perpendicular as required to line and plane of surface.
- B. Items set into concrete or masonry.

1. Provide temporary bracing for such items until concrete or masonry is set.
 2. Place in accordance with setting drawings and instructions.
 3. Build strap anchors, into masonry as work progresses.
- C. Set frames of gratings, covers, corner guards, trap doors and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.
- D. Field weld in accordance with AWS.
1. Design and finish as specified for shop welding.
 2. Use continuous weld unless specified otherwise.
- E. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.
- F. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.
- G. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.
- H. Secure escutcheon plate with set screw.

3.2 INSTALLATION OF SUPPORTS

- A. Anchorage to structure.
1. Secure angles or channels and clips to overhead structural steel by continuous welding unless bolting is shown.
 2. Secure supports to concrete inserts by bolting or continuous welding as shown.
 3. Secure supports to mid height of concrete beams when inserts do not exist with expansion bolts and to slabs, with expansion bolts. unless shown otherwise.
 4. Secure steel plate or hat channels to studs as detailed.
- B. Ceiling Hung Toilet Stalls:
1. Securely anchor hangers of continuous steel channel above pilasters to structure above.
 2. Bolt continuous steel angle at wall to masonry or weld to face of each metal stud.

3. Secure brace for steel channels over toilet stall pilasters to wall angle supports with bolts at each end spaced as shown.
 4. Install diagonal angle brace where the suspended ceiling over toilet stalls does not extend to side wall of room.
 5. Install stud bolts in lower flange of channel before installing furred down ceiling over toilet stalls.
 6. Install support for ceiling hung pilasters at entrance screen to toilet room similar to toilet stall pilasters.
- C. Supports for Wall Mounted items:
1. Locate center of support at anchorage point of supported item.
 2. Locate support at top and bottom of wall hung cabinets.
 3. Locate support at top of floor cabinets and shelving installed against walls.
 4. Locate supports where required for items shown.
- D. Support at Ceiling for X-ray Tube Stand and Radiographic Equipment:
1. Bolt modular steel channel frames to hangers as shown, anchored to structure above.
 2. Fasten frames with modular channel manufacturers fittings, bolts, and nuts. Space modular channel supports and hangers as shown and as required to suit equipment furnished.
 3. Install closure plates in channels at ceiling where channel opening is visible. Coordinate and cut plates to fit tight against equipment anchors after equipment anchors are installed.
- E. Ceiling Support for Operating Light:
1. Anchor support to structure above as shown.
 2. Set leveling plate as shown level with ceiling.
 3. Secure operating light to leveling plate in accordance with light manufacturer's requirements.
- F. Supports for intravenous (IV) Track and Cubicle Curtain Track:
1. Install assembly where shown after ceiling suspension grid is installed.
 2. Drill angle for bolt and weld nut to angle prior to installation of tile.
- G. Support for cantilever grab bars:
1. Locate channels or tube in partition for support as shown and extend full height from floor to underside of structural slab above.

2. Anchor at top and bottom with angle clips bolted to channels or tube with two, 9 mm (3/8 inch) diameter bolts.
3. Anchor to floors and overhead construction with two 9 mm (3/8 inch) diameter bolts.
4. Fasten clips to concrete with expansion bolts, and to steel with machine bolts or welds.

H. Supports for Trapeze Bars:

1. Secure plates to overhead construction with fasteners as shown.
2. Secure angle brace assembly to overhead construction with fasteners as shown and bolt plate to braces.
3. Fit modular channel unit flush with finish ceiling, and secure to plate with modular channel unit manufacturer's standard fittings through steel shims or spreaders as shown.
 - a. Install closure plates in channel between eye bolts.
 - b. Install eyebolts in channel.

I. Support for Communion Rail Posts:

1. Anchor steel plate supports for posts as shown.
2. Use four bolts per plate, locate two at top and two at bottom.
3. Use lag bolts.

3.3 COVERS AND FRAMES FOR PITS AND TRENCHES

- A. Set frame and cover flush with finish floor.
- B. Secure plates to frame with flat head countersunk screws.
- C. Set gratings loose in drainage trenches or over pits unless shown anchored.

3.4 FRAMES FOR LEAD LINED DOORS

- A. Secure jamb angle clips and plates, at top and bottom with two, 9 mm (3/8 inch) expansion bolts to concrete.
- B. Secure 150 x 90 x 13 mm (6 x 3-1/2 x 1/2 inch) angle to steel framing for anchorage when expansion bolts to concrete is not possible.
- C. Secure clips by welding to steel.
- D. At interstitial spaces, anchor jamb angles as shown.

3.5 DOOR FRAMES

- A. Secure clip angles at bottom of frames to concrete slab with expansion bolts as shown.
- B. Level and plumb frame; brace in position required.

- C. At masonry, set frames in walls so anchors are built-in as the work progresses unless shown otherwise.
- D. Set frames in formwork for frames cast into concrete.
- E. Where frames are set in prepared openings, bolt to wall with spacers and expansion bolts.

3.6 OTHER FRAMES

- A. Set frame flush with surface unless shown otherwise.
- B. Anchor frames at ends and not over 450 mm (18 inches) on centers unless shown otherwise.
- C. Set in formwork before concrete is placed.

3.7 GUARDS

- A. Steel Angle Corner Guards:
 - 1. Build into masonry as the work progress.
 - 2. Set into formwork before concrete is placed.
 - 3. Set angles flush with edge of opening and finish floor or wall or as shown.
 - 4. At existing construction fasten angle and filler piece to adjoining construction with 16 mm (5/8 inch) diameter by 75 mm (3 inch) long expansion bolts 450 mm (18 inches) on center.
 - 5. Install Guard Angles at Edges of Trench, Stairwell, Openings in Slab, Dock Leveler and Overhead Doors where shown.
- B. Channel Guard at Top Edge of Concrete Platforms:
 - 1. Install in formwork before concrete is placed.
 - 2. Set channel flush with top of the platform.
- C. Wheel Guards:
 - 1. Set flanges of wheel guard at least 50 mm (2 inches) into pavement.
 - 2. Anchor to walls as shown, expansion bolt if not shown.

3.8 GRATINGS

- A. Set grating flush with finish floor, top of curb, or areaway wall. Set frame so that horizontal leg of angle frame is flush with face of wall except when frame is installed on face of wall.
- B. Set frame in formwork before concrete is placed.
- C. Where grating terminates at a wall bolt frame to concrete or masonry with expansion bolts unless shown otherwise.
- D. Secure removable supporting members in place with stainless steel bolts.

E. Bolt gratings to supports.

3.9 STEEL LINTELS

- A. Use lintel sizes and combinations shown or specified.
- B. Install lintels with longest leg upstanding, except for openings in 150 mm (6 inch) masonry walls install lintels with longest leg horizontal.
- C. Install lintels to have not less than 150 mm (6 inch) bearing at each end for nonbearing walls, and 200 mm (8 inch) bearing at each end for bearing walls.

3.10 SHELF ANGLES

- A. Anchor shelf angles with 19 mm (3/4 inch) bolts unless shown otherwise in adjustable malleable iron inserts, set level at elevation shown.
- B. Provide expansion space at end of members.

3.11 PLATE DOOR SILL

- A. Install after roofing base flashing and counter flashing work is completed.
- B. Set in sealant and bolt to curb.

3.12 SAFETY NOSINGS

- A. Except as specified and where preformed rubber treads are shown or specified install safety nosings at the following:
 - 1. Exterior concrete steps.
 - 2. Door sills of areaway entrances curbs.
 - 3. Exposed edges of curbs of door sills at transformer and service rooms.
 - 4. Interior concrete steps, including concrete filled treads of metal stairs of service stairs.
- B. Install flush with horizontal and vertical surfaces.
- C. Install nosing to within 100 mm (4 inches) of ends of concrete stair treads, except where shown to extend full width.
- D. Extend nosings full width of door openings.
- E. Extend nosings, full width between stringers of metal stairs, and terminate at point of curvature of steps having short radius curved ends.

3.13 LADDERS

- A. Anchor ladders to walls and floors with expansion bolts through turned lugs or angle clips or brackets.

- B. In elevator pits, set ladders to clear all elevator equipment where shown on the drawings.
 - 1. Where ladders are interrupted by division beams, anchor ladders to beams by welding, and to floors with expansion bolts.
 - 2. Where ladders are adjacent to division beams, anchor ladders to beams with bent steel plates, and to floor with expansion bolts.
- C. Ladder Rungs:
 - 1. Set ladder rungs into formwork before concrete is placed.
 - 2. Set step portion of rung 150 mm (6 inches) from wall.
 - 3. Space rungs approximately 300 mm (12 inches) on centers.
 - 4. Where only one rung is required, locate it 400 mm (16 inches) above the floor.

3.14 RAILINGS

- A. Steel Posts:
 - 1. Secure fixed posts to concrete with expansion bolts through flanged fittings except where sleeves are shown with pourable grout.
 - 2. Install sleeves in concrete formwork.
 - 3. Set post in sleeve and pour grout to surface. Apply beveled bead of urethane sealant at perimeter of post or under flange fitting as specified in Section 07 92 00, JOINT SEALANTS—on exterior posts.
 - 4. Secure removable posts to concrete with either machine screws through flanged fittings which are secured to inverted flanges embedded in and set flush with finished floor, or set posts in close fitting pipe sleeves without grout.
 - 5. Secure sliding flanged fittings to posts at base with set screws.
 - 6. Secure fixed flanged fittings to concrete with expansion bolts.
 - 7. Secure posts to steel with welds.
- B. Aluminum Railing, Stainless Steel Railing, and Ornamental Railing Posts:
 - 1. Install pipe sleeves in concrete formwork.
 - 2. Set posts in sleeve and pour grout to surface on exterior locations and to within 6 mm (1/4 inch) of surface for interior locations except to where posts are required to be removable.
 - 3. Apply beveled bead of urethane sealant over sleeve at post perimeter for exterior posts and flush with surface for interior posts as specified in Section 07 92 00, JOINT SEALANTS.

C. Anchor to Walls:

1. Anchor rails to concrete or solid masonry with machine screws through flanged fitting to steel plate.
 - a. Anchor steel plate to concrete or solid masonry with expansion bolts.
 - b. Anchor steel plate to hollow masonry with toggle bolts.
2. Anchor flanged fitting with toggle bolt to steel support in frame walls.

D. Removable Rails:

1. Rest rails in brackets at each end and secure to bracket with stainless steel bolts and nuts where part of a continuous railing.
2. Rest rail posts in sleeves where not part of a continuous railing. Do not grout posts.

E. Gates:

1. Hang gate to swing as shown.
2. Bolt gate hinges to jamb post with clamp on or through bolts.

F. Chains:

1. Eye bolt chains to pipe posts.
2. Eye bolt anchoring at walls.
 - a. Expansion bolt to concrete or solid masonry.
 - b. Toggle bolt to hollow masonry of frame wall installed support.

G. Handrails:

1. Anchor brackets for metal handrails as detailed.
2. Install brackets within 300 mm (12 inches) of return of walls, and at evenly spaced intermediate points not exceeding 1200 mm (4 feet) on centers unless shown otherwise.
3. Expansion bolt to concrete or solid masonry.
4. Toggle bolt to installed supporting frame wall and to hollow masonry unless shown otherwise.

3.15 CATWALK AND PLATFORMS

- A. Expansion bolt members to concrete unless shown otherwise.
- B. Bolt or weld structural components together including ladders and stairs to support system.
- C. Weld railings to structural framing.
- D. Bolt or weld walk surface to structural framing.
- E. Smooth field welds and spot prime damaged prime paint surface.

F. Fasten removable members with stainless steel fasteners.

3.16 SIDEWALK DOOR, TRAP DOORS, AND FRAMES

- A. Set frame flush with finished concrete slab or curb.
- B. Secure well linings to structure with expansion bolts unless shown otherwise.
- C. Bolt ceiling hatch to well lining angle brace and to angle iron frames near corners and 300 mm (12 inches) on centers with not less than 9 mm (3/8 inch) roundhead machine screws.
- D. Coordinate sidewalk door drain connections with plumbing work.

3.17 SCREENED ACCESS DOOR

- A. Set frame in opening so that clearance at jambs is equal and secure with expansion bolts.
- B. Use shims at bolts to prevent deformation of frame members in prepared openings.
- C. Set frame in mortar bed and build in anchors as the masonry work progresses.
- D. Grout jambs solid with mortar.
- E. Secure insect screen to inside of door with stainless steel fasteners on doors in exterior walls.

3.18 STEEL COMPONENTS FOR MILLWORK ITEMS

Coordinate and deliver to Millwork fabricator for assembly where millwork items are secured to metal fabrications.

3.19 INSTALLATION OF STEEL PIPE BOLLARD

Set bollards vertically in concrete piers. Compressive strength of concrete piers shall be 21MPa 3000psi. For dimensions of concrete piers See standard detail SD320523-04.

3.20 CLEAN AND ADJUSTING

- A. Adjust movable parts including hardware to operate as designed without binding or deformation of the members centered in the opening or frame and, where applicable, contact surfaces fit tight and even without forcing or warping the components.
- B. Clean after installation exposed prefinished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the project.

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SECTION 05 51 00
METAL STAIRS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies steel stairs with railings.
- B. Types:
 - 1. Closed riser stairs with concrete filled treads and platforms.
 - 2. Industrial stairs: Open riser stairs.

1.2 RELATED WORK:

- A. Concrete fill for treads and platforms: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Wall handrails and railings for other than steel stairs:
Section 05 50 00, METAL FABRICATIONS.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: Show design, fabrication details, installation, connections, material, and size of members.
- C. Fabrication qualifications.
- D. Installer qualifications.
- E. Calculations.
- F. Welding qualifications.

1.4 QUALITY ASSURANCE:

- A. Fabricator: A firm with a minimum of three (3) years' experience in type of work required by this section. Submit fabricator qualifications.
- B. Installer: A firm with a minimum of three (3) years' experience in type of work required by this section. Submit installer qualifications.
- C. Calculations: Provide professionally prepared calculations and certification of performance of this work, signed and sealed by a Professional Engineer registered in the state where the work is located. Perform structural design of the stair including supports for the metal stair frame. Indicate how Design Criteria as specified have been incorporated into the design.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M and AWS D1.3/D1.3M.

1.5 APPLICATION PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation.
- B. American Society of Mechanical Engineers (ASME):
- B18.2.1-12Square, Hex, Heavy Hex, and Askew Head Bolts
and Hex, Heavy Hex, Hex Flange, Lobed Head, and
Lag Screws (Inch Series)
- B18.2.3.8M-81 (R2005) ...Metric Heavy Lag Screws
- B18.6.1-81 (R2008)Wood Screws (Inch Series)
- B18.6.3-13Machine Screws, Tapping Screws, and Metallic
Drive Screws (Inch Series)
- B18.6.5M-10Metric Thread Forming and Thread Cutting
Tapping Screws
- B18.6.7M-10Metric Machine Screws
- B18.22M-81 (R2010)Metric Plain Washers
- B18.21.1-09Washers: Helical Spring-Lock, Tooth Lock, and
Plain Washer (Inch Series)
- C. ASTM International (ASTM):
- A36/A36M-14Structural Steel
- A47/A47M-99 (R2014)Ferritic Malleable Iron Castings
- A48/A48M-03 (R2012)Gray Iron Castings
- A53/A53M-12Pipe, Steel, Black and Hot-Dipped Zinc-Coated
Welded and Seamless
- A123/A123M-13Zinc (Hot-Dip Galvanized) Coatings on Iron and
Steel Products
- A153/A153M-09Zinc Coating (Hot-Dip) on Iron and Steel
Hardware
- A307-14Carbon Steel Bolts, Studs and Threaded Rod
60,000 PSI Tensile Strength
- A653/A653M-13Steel Sheet, Zinc Coated (Galvanized) or Zinc
Alloy Coated (Galvannealed) by the Hot-Dip
Process
- A786/A786M-05 (R2009) ...Rolled Steel Floor Plates
- A1008/A1008M-13Steel, Sheet, Cold-Rolled, Carbon, Structural,
High-Strength, Low-Alloy
- A1011/A1011M-14Steel, Sheet and Strip, Strip, Hot-Rolled
Carbon, Structural, High-Strength, Low-Alloy

- D. American Welding Society (AWS):
 - D1.1/D1.1M-10Structural Welding Code-Steel
 - D1.3/D1.3M-08Structural Welding Code-Sheet Steel
- E. The National Association of Architectural Metal Manufactures (NAAMM)
 - Manuals:
 - MBG 531-09Metal Bar Gratings
 - AMP521-01Pipe Railing Manual, Including Round Tube
- F. American Iron and Steel Institute (AISI):
 - S100-12Design of Cold-Formed Steel Structural Members
- G. National Fire Protection Association (NFPA):
 - 101-15Life Safety Code
- H. Society for Protective Coatings (SSPC):
 - Paint 25(1997; E 2004) .Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA:

- A. Design stairs to support live load of 4.79 kN/sq. m (100 lbf/ sq. ft.) and a concentrated load of 1.33 kN (300 lbf) applied on an area of 2580 sq. mm (4 sq. in.).
 - 1. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Provide stair framing capable of withstanding stresses resulting from railing loads in addition to the loads specified above. Limit deflection of treads, platforms, and framing members to L/360 or 6.4 mm (1/4 inch), whichever is less.
- B. Provide structural design, fabrication and assembly in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.
- C. Design Grating treads in accordance with NAAMM Metal Bar Grating Manual.
- D. Design handrails and top rails of guards to support uniform load of not 0.73 kN/m (50 lbf/ft.) applied in any direction and a concentrated load of 0.89 kN (200 lbf) applied in any direction. Uniform and concentrated loads need not be assumed to act concurrently.
- E. Infill of guards to support concentrated load of 0.22 kN (50 lbf) applied horizontally on an area of 0.093 sq. m (1 sq. ft.).
- F. Design fire stairs to conform to NFPA 101.

2.2 MATERIALS:

- A. Steel Pipe: ASTM A53/A53M, Standard Weight, zinc coated.
- B. Steel Grating: Metal bar type grating NAAMM BG.
- C. Sheet Steel: ASTM A1008/A1008M.
- D. Structural Steel: ASTM A36/A36M.
- E. Steel Floor Plate: ASTM A786/A786M.
- F. Steel Decking: Form from zinc coated steel conforming to ASTM A653/A653M, with properties conforming to AISI S100 Specification for the Design of Cold-Formed Steel Structural Members.
- G. Steel Plate: ASTM A1011/A1011M.
- H. Iron Castings: ASTM A48/A48M, Class 30.
- I. Malleable Iron Castings: ASTM A47/A47M.

2.3 FABRICATION GENERAL:

- A. Fasteners:
 - 1. Conceal bolts and screws wherever possible.
 - 2. Use countersunk heads on exposed bolts and screws with ends of bolts and screws dressed flush after nuts are set.
 - 3. Galvanized zinc-coated fasteners in accordance with ASTM A153/A153M and used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.
 - 4. Standard/regular hexagon-head bolts and nuts be conforming to ASTM A307, Grade A.
 - 5. Square-head lag bolts conforming to ASME B18.2.3.8M, ASME B18.2.1.
 - 6. Machine screws cadmium-plated steel conforming to ASME B18.6.7M, ASME B18.6.3.
 - 7. Wood screws, flat-head carbon steel conforming to ASME B18.6.5M, ASME B18.6.1.
 - 8. Plain washers, round, general-assembly-grade, carbon steel conforming to ASME B18.22M, ASME B18.21.1.
 - 9. Lockwashers helical spring, carbon steel conforming to ASME B18.2.1, ASME B18.2.3.8M.
- B. Welding:
 - 1. Structural steel, AWS D1.1/D1.1M, and sheet steel, AWS D1.3/D1.3M.
 - 2. Where possible, locate welds on unexposed side.
 - 3. Grind exposed welds smooth and true to contour of welded member.
 - 4. Remove welding splatter.
- C. Remove sharp edges and burrs.

- D. Fit stringers to head channel and close ends with steel plates welded in place where shown.
- E. Fit face stringer to newel post by tenoning into newel post, or by notching and fitting face stringer to side of newel where shown.
- F. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 0.8 mm (1/32 inch), and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.
- G. Continuously weld corners and seams in accordance with the recommendations of AWS D1.1/D1.1M. Grind smooth exposed welds and flush to match and blend with adjoining surfaces.
- H. Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.
- I. Provide and coordinate anchorage of the type indicated with the supporting structure. Fabricate anchoring devices, space as indicated and required to provide adequate support for the intended use of the work.
- J. Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.4 RAILINGS:

- A. Fabricate railings, including handrails, from steel pipe.
 - 1. Connections may be standard fittings designed for welding or coped or mitered pipe with full welds.
 - 2. Wall handrails are provided under Section 05 50 00, METAL FABRICATIONS.
- B. Return ends of handrail to wall and close free end.
- C. Provide standard terminal castings where fastened to newel.
- D. Space intermediate posts not over 1828 mm (6 feet) on center between end post
- E. Fabricate handrail brackets from cast malleable iron.
- F. Provide standard terminal fittings at ends of post and rails.

2.5 CLOSED RISER STAIRS:

- A. Provide treads, risers, platforms, railings, stringers, headers and other supporting members.

- B. Fabricate pans for treads and platforms, and risers from sheet steel.
- C. Form risers with sanitary cove.
- D. Fabricate stringers, headers, and other supporting members from structural steel.
- E. Construct newel posts of steel tubing having wall thickness not less than 5 mm (3/16-inch), with forged steel caps and drops.

2.6 INDUSTRIAL STAIRS:

- A. Provide treads, platforms, railings, stringers and other supporting members as shown.
- B. Treads and platforms of checkered steel floor plate:
 - 1. Turn floor plate down to form nosing on treads and edge of platform at head of stairs.
 - 2. Support tread and platforms with angles welded to plate.
 - 3. Do not leave exposed fasteners on top of treads or platform surfaces.
- C. Treads and platforms of steel grating:
 - 1. Fabricate steel grating treads and platforms in accordance with requirements of NAAMM MBG 531-09.
 - 2. Provide end-banding bars, except where carrier angle is used at tread ends.
 - 3. Support treads by use of carrier plates or carrier angle. Use carrier plate end banding bars on exterior stairs.
 - 4. Provide abrasive nosing on treads and edge of platforms at head of stairs.
 - 5. Provide toe plates on platforms where shown.

PART 3 - EXECUTION

3.1 STAIR INSTALLATION:

- A. Provide hangers and struts required to support the loads imposed.
- B. Perform job site welding and bolting as specified for shop fabrication.
- C. Set stairs and other members in position and secure to structure as shown.
- D. Install stairs plumb, level and true to line.
- E. Provide steel closure plate to fill gap between the stringer and surrounding wall. Weld and apply primer, ready to accept paint finish.

3.2 RAILING INSTALLATION:

- A. Install standard terminal fittings at ends of posts and rails.

- B. Secure brackets, posts and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.
- C. Set rails horizontal or parallel to rake of stairs to within 3 mm in 3658 mm (1/8-inch in 12 feet).
- D. Set posts plumb and aligned to within 3 mm in 3658 mm (1/8-inch in 12 feet).

3.3 FIELD PRIME PAINTING:

- A. Touch-up abraded areas with same primer paint used for shop priming.
- B. Touch up abraded galvanized areas.

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies wood blocking, framing, sheathing, furring, nailers, sub-flooring, rough hardware, and light wood construction.

1.2 RELATED WORK:

- A. Sustainable design requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- B. Gypsum sheathing: Section 09 29 00, GYPSUM BOARD.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Sustainable Design Submittals, as described below:
1. Postconsumer and preconsumer recycled content as specified in PART 2 - PRODUCTS.
 2. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.
- C. Shop Drawings showing framing connection details, fasteners, connections and dimensions.
- D. Manufacturer's Literature and Data:
1. Submit data for lumber, panels, hardware and adhesives.
 2. Submit data for wood-preservative treatment from chemical treatment manufacturer and certification from treating plants that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 3. Submit data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 4. For products receiving a waterborne treatment, submit statement that moisture content of treated materials was reduced to levels specified before shipment to project site.
- E. Manufacturer's certificate for unmarked lumber.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Protect lumber and other products from dampness both during and after delivery at site.
- B. Pile lumber in stacks in such manner as to provide air circulation around surfaces of each piece.
- C. Stack plywood and other board products so as to prevent warping.
- D. Locate stacks on well drained areas, supported at least 152 mm (6 inches) above grade and cover with well-ventilated sheds having firmly constructed over hanging roof with sufficient end wall to protect lumber from driving rain.

1.5 QUALITY ASSURANCE:

- A. Installer: A firm with a minimum of three (3) years' experience in the type of work required by this section.

1.6 GRADING AND MARKINGS:

- A. Any unmarked lumber or plywood panel for its grade and species will not be allowed on VA Construction sites for lumber and material not normally grade marked, provide manufacturer's certificates (approved by an American Lumber Standards approved agency) attesting that lumber and material meet the specified the specified requirements.

1.7 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in the text by basic designation only.
- B. American Forest and Paper Association (AFPA):
 - NDS-15National Design Specification for Wood Construction
 - WCD1-01Details for Conventional Wood Frame Construction
- C. American Institute of Timber Construction (AITC):
 - A190.1-07Structural Glued Laminated Timber
- D. American Society of Mechanical Engineers (ASME):
 - B18.2.1-12 (R2013)Square and Hex Bolts and Screws
 - B18.2.2-10Square and Hex Nuts
 - B18.6.1-81 (R2008)Wood Screws
- E. American Plywood Association (APA):
 - E30-11Engineered Wood Construction Guide
- F. ASTM International (ASTM):

- A653/A653M-13Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot Dip Process
- C954-11Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.033 inch (2.24 mm) to 0.112-inch (2.84 mm) in thickness
- C1002-14Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Metal Studs
- D198-14Test Methods of Static Tests of Lumber in Structural Sizes
- D2344/D2344M-13Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
- D2559-12aAdhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions
- D3498-03 (R2011)Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems
- D6108-13Test Method for Compressive Properties of Plastic Lumber and Shapes
- D6109-13Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber and Related Products
- D6111-13aTest Method for Bulk Density and Specific Gravity of Plastic Lumber and Shapes by Displacement
- D6112-13Test Methods for Compressive and Flexural Creep and Creep-Rupture of Plastic Lumber and Shapes
- F844-07a (R2013)Washers, Steel, Plan (Flat) Unhardened for General Use
- F1667-13Nails, Spikes, and Staples
- G. American Wood Protection Association (AWPA):
AWPA Book of Standards
- H. Commercial Item Description (CID):
A-A-55615Shield, Expansion (Wood Screw and Lag Bolt Self Threading Anchors)
- I. Forest Stewardship Council (FSC):

FSC-STD-01-001 (Ver. 4-0) FSC Principles and Criteria for Forest
Stewardship

- J. Military Specification (Mil. Spec.):
MIL-L-19140ELumber and Plywood, Fire-Retardant Treated
- K. Environmental Protection Agency (EPA):
40 CFR 59(2014)National Volatile Organic Compound Emission
Standards for Consumer and Commercial Products
- L. Truss Plate Institute (TPI):
TPI-85Metal Plate Connected Wood Trusses
- M. U.S. Department of Commerce Product Standard (PS)
PS 1-95Construction and Industrial Plywood
PS 20-10American Softwood Lumber Standard
- N. ICC Evaluation Service (ICC ES):
AC09Quality Control of Wood Shakes and Shingles
AC174Deck Board Span Ratings and Guardrail Systems
(Guards and Handrails)

PART 2 - PRODUCTS

2.1 LUMBER:

- A. Unless otherwise specified, each piece of lumber must bear grade mark, stamp, or other identifying marks indicating grades of material, and rules or standards under which produced.
 - 1. Identifying marks are to be in accordance with rule or standard under which material is produced, including requirements for qualifications and authority of the inspection organization, usage of authorized identification, and information included in the identification.
 - 2. Inspection agency for lumber approved by the Board of Review, American Lumber Standards Committee, to grade species used.
- B. Structural Members: Species and grade as listed in the AFPA NDS having design stresses as shown.
- C. Lumber Other Than Structural:
 - 1. Unless otherwise specified, species graded under the grading rules of an inspection agency approved by Board of Review, American Lumber Standards Committee.
 - 2. Framing lumber: Minimum extreme fiber stress in bending of 7584 kPa (1100 PSI).

3. Furring, blocking, nailers and similar items 101 mm (4 inches) and narrower Standard Grade; and, members 152 mm (6 inches) and wider, Number 2 Grade.
4. Board Sub-flooring: Shiplap edge, 25 mm (1 inch) thick, not less than 203 mm (8 inches) wide.

D. Sizes:

1. Conforming to PS 20.
2. Size references are nominal sizes, unless otherwise specified, actual sizes within manufacturing tolerances allowed by standard under which produced.

E. Moisture Content:

1. Maximum moisture content of wood products is to be as follows at the time of delivery to site.
 - a. Boards and lumber 50 mm (2 inches) and less in thickness: 19 percent or less.
 - b. Lumber over 50 mm (2 inches) thick: 25 percent or less.

F. Fire Retardant Treatment:

1. Comply with Mil Spec. MIL-L-19140.
2. Treatment and performance inspection, by an independent and qualified testing agency that establishes performance ratings.

G. Preservative Treatment:

1. Do not treat Heart Redwood and Western Red Cedar.
2. Treat wood members and plywood exposed to weather or in contact with plaster, masonry or concrete, including framing of open roofed structures; sills, sole plates, furring, and sleepers that are less than 610 mm (24 inches) from ground; nailers, edge strips, blocking, crickets, curbs, cant, vent strips and other members provided in connection with roofing and flashing materials.
3. Treat other members specified as preservative treated (PT).
4. Preservative treat by the pressure method complying with AWPA Book use category system standards U1 and T1, except any process involving the use of Chromated Copper Arsenate (CCA) or other agents classified as carcinogenic for pressure treating wood is not permitted.

2.2 PLYWOOD:

- A. Comply with PS 1.
- B. Bear the mark of a recognized association or independent inspection agency that maintains continuing control over quality of plywood which identifies compliance by veneer grade, group number, span rating where applicable, and glue type.
- C. Sheathing:
 - 1. APA rated Exposure 1 or Exterior; panel grade CD or better.
 - 2. Wall sheathing:
 - a. Minimum 9 mm (11/32 inch) thick with supports 406 mm (16 inches) on center and 12 mm (15/32 inch) thick with supports 610 mm (24 inches) on center unless specified otherwise.
 - b. Minimum 1200 mm (48 inches) wide at corners without corner bracing of framing.

2.3 ROUGH HARDWARE AND ADHESIVES:

- A. Anchor Bolts:
 - 1. ASME B18.2.1 and ASME B18.2.2 galvanized, 13 mm (1/2 inch) unless shown otherwise.
 - 2. Extend at least 203 mm (8 inches) into masonry or concrete with ends bent 50 mm (2 inches).
- B. Miscellaneous Bolts: Expansion Bolts: C1D A-A-55615; lag bolt, long enough to extend at least 65 mm (2-1/2 inches) into masonry or concrete. Provide 13 mm (1/2 inch) bolt unless shown otherwise.
- C. Washers
 - 1. ASTM F844.
 - 2. Provide zinc or cadmium coated steel or cast iron for washers exposed to weather.
- D. Screws:
 - 1. Wood to Wood: ASME B18.6.1 or ASTM C1002.
 - 2. Wood to Steel: ASTM C954, or ASTM C1002.
- E. Nails:
 - 1. Size and type best suited for purpose unless noted otherwise. Provide aluminum-alloy nails, plated nails, or zinc-coated nails, for nailing wood work exposed to weather and on roof blocking.
 - 2. ASTM F1667:
 - a. Common: Type I, Style 10.
 - b. Concrete: Type I, Style 11.

- c. Barbed: Type I, Style 26.
- d. Underlayment: Type I, Style 25.
- e. Masonry: Type I, Style 27.
- f. Provide special nails designed for use with ties, strap anchors, framing connectors, joists hangers, and similar items. Nails not less than 32 mm (1-1/4 inches) long, 8d and deformed or annular ring shank.

F. Adhesives:

- 1. For field-gluing plywood to lumber framing floor or roof systems: ASTM D3498.
- 2. Adhesives to have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, (EPA Method 24)

PART 3 - EXECUTION

3.1 INSTALLATION OF FRAMING MEMBERS:

A. Partition and Wall Framing:

- 1. Provide 50 mm by 101 mm (2 inch by 4 inch) studs spaced 406 mm (16 inches) on centers; unless otherwise indicated on contract documents.
- 2. Install double studs at openings and triple studs at corners.
- 3. Installation of sole plate:
 - a. Anchor plates of walls or partitions resting on concrete floors in place with expansion bolts, one (1) near ends of piece and at intermediate intervals of not more than 1219 mm (4 feet) or with power actuated drive pins with threaded ends of suitable type and size, spaced 610 mm (2 feet) on center unless shown otherwise.
- 4. Headers or Lintels:
 - a. Make headers for openings of two (2) pieces of 50 mm (2 inch) thick lumber of size shown with plywood filler to finish flush with face of studs or solid lumber of equivalent size.
 - b. Support ends of headers on top of stud cut for height of opening. Spike cut stud to adjacent stud. Spike adjacent stud to header.
- 5. Provide double top plates, with members lapped at least 610 mm (2-foot) spiked together.
- 6. Install intermediate cut studs over headers and under sills to maintain uniformity of stud spacing.
- 7. Provide single sill plates at bottom of opening unless otherwise indicated in contract documents.

8. Install 50 mm (2 inch) blocking for firestopping so that maximum dimension of any concealed space is not over 2438 mm (8 feet) in accordance with AFPA WCD1.
 9. Install corner bracing when plywood or structured use panel sheathing is not used.
 - a. Let corner bracing into exterior surfaces of studs at an angle of approximately 45 degrees, extended completely over walls plates, and secured at bearing with two (2) nails.
 - b. Provide 25 mm by 101 mm (1 inch by 4 inch) corner bracing.
- B. Rough Bucks:
1. Install rough wood bucks at opening in masonry or concrete where wood frames or trim occur.
 2. Brace and maintain bucks plumb and true until masonry has been built around them or concrete cast in place.
 3. Cut rough bucks from 50 mm (2 inch) thick stock, of same width as partitions in which they occur and of width shown in exterior walls.
 4. Extend bucks full height of openings and across head of openings; fasten securely with anchors specified.
- C. Sheathing:
1. Provide plywood or structural-use panels for sheathing.
 2. Lay panels with joints staggered, with edge and ends 3 mm (1/8 inch) apart and nailed over bearings as specified.
 3. Set nails not less than 9 mm (3/8 inch) from edges.
 4. Install 50 mm by 101 mm (2 inch by 4 inch) blocking spiked between joists, rafters and studs to support edge or end joints of panels.
 5. Match and align sheathing which is an extension of work in place to existing.

- - - E N D - - -

**SECTION 07 60 00
FLASHING AND SHEET METAL**

PART 1 - GENERAL

1.1 DESCRIPTION

Formed sheet metal work for wall and roof flashing, copings, roof edge metal, fasciae, drainage specialties, and formed expansion joint covers are specified in this section. Match existing where possible.

1.2 RELATED WORK

- A. Flashing components of factory finished roofing and wall systems: Division 07 roofing and wall system sections.
- B. Joint Sealants: Section 07 92 00, JOINT SEALANTS.
- C. Color of factory coated exterior architectural metal and anodized aluminum items: Match existing.
- D. Integral flashing components of manufactured roof specialties and accessories or equipment: Division 23 HVAC sections.
- E. Paint materials and application: Section 09 91 00, PAINTING.
- F. Flashing and sheet metal in connection with prefabricated metal buildings: (NOT USED)

1.3 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. Aluminum Association (AA):
 - AA-C22A41Aluminum Chemically etched medium matte, with clear anodic coating, Class I Architectural, 0.7-mil thick
 - AA-C22A42Chemically etched medium matte, with integrally colored anodic coating, Class I Architectural, 0.7 mils thick
 - AA-C22A44Chemically etched medium matte with electrolytically deposited metallic compound, integrally colored coating Class I Architectural, 0.7-mil thick finish

- C. American National Standards Institute/Single-Ply Roofing
Institute/Factory Mutual (ANSI/SPRI/FM):
- 4435/ES-1-11Wind Design Standard for Edge Systems Used with
Low Slope Roofing Systems
- D. American Architectural Manufacturers Association (AAMA):
- AAMA 620-02Voluntary Specification for High Performance
Organic Coatings on Coil Coated Architectural
Aluminum
- AAMA 621-02Voluntary Specification for High Performance
Organic Coatings on Coil Coated Architectural
Hot Dipped Galvanized (HDG) and Zinc-Aluminum
Coated Steel Substrates
- E. ASTM International (ASTM):
- A240/A240M-15Standard Specification for Chromium and
Chromium-Nickel Stainless Steel Plate, Sheet
and Strip for Pressure Vessels and for General
Applications.
- A653/A653M-15Steel Sheet Zinc-Coated (Galvanized) or Zinc
Alloy Coated (Galvanized) by the Hot- Dip
Process
- B32-14Solder Metal
- B209-14Aluminum and Aluminum-Alloy Sheet and Plate
- B370-12Copper Sheet and Strip for Building
Construction
- D173-03 (R2011)Bitumen-Saturated Cotton Fabrics Used in
Roofing and Waterproofing
- D412-15Vulcanized Rubber and Thermoplastic Elastomers-
Tension
- D1187-97 (R2011)Asphalt Base Emulsions for Use as Protective
Coatings for Metal
- D1784-11Rigid Poly (Vinyl Chloride) (PVC) Compounds and
Chlorinated Poly (Vinyl Chloride) (CPVC)
Compounds
- D3656-13Insect Screening and Louver Cloth Woven from
Vinyl-Coated Glass Yarns
- D4586-12Asphalt Roof Cement, Asbestos Free

- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): Architectural Sheet Metal Manual.
- G. National Association of Architectural Metal Manufacturers (NAAMM): AMP 500-06Metal Finishes Manual
- H. Federal Specification (Fed. Spec):
 - A-A-1925AShield, Expansion; (Nail Anchors)
 - UU-B-790ABuilding Paper, Vegetable Fiber
- I. International Code Commission (ICC): International Building Code, Current Edition

1.4 PERFORMANCE REQUIREMENTS (NOT USED)

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: For all specified items, including:
 - 1. Flashings
 - 2. Copings
 - 3. Gravel Stop-Fascia
 - 4. Gutter and Conductors
 - 5. Expansion joints
 - 6. Fascia-cant
- C. Manufacturer's Literature and Data: For all specified items, including:
 - 1. Two-piece counterflashing
 - 2. Thru wall flashing
 - 3. Expansion joint cover, each type
 - 4. Nonreinforced, elastomeric sheeting
 - 5. Copper clad stainless steel
 - 6. Polyethylene coated copper
 - 7. Bituminous coated copper
 - 8. Copper covered paper
 - 9. Fascia-cant
- D. Certificates: Indicating compliance with specified finishing requirements, from applicator and contractor.

PART 2 - PRODUCTS

2.1 FLASHING AND SHEET METAL MATERIALS

- A. Stainless Steel: ASTM A240, Type 302B, dead soft temper.
- B. Copper ASTM B370, cold-rolled temper.
- C. Bituminous Coated Copper: Minimum copper ASTM B370, weight not less than 1 kg/m² (3 oz/sf). Bituminous coating shall weigh not less than 2 kg/m² (6 oz/sf); or, copper sheets may be bonded between two layers of coarsely woven bitumen-saturated cotton fabric ASTM D173. Exposed fabric surface shall be crimped.
- D. Copper Covered Paper: Fabricated of electro-deposit pure copper sheets ASTM B 370, bonded with special asphalt compound to both sides of creped, reinforced building paper, UU-B-790, Type I, style 5, or to a three ply sheet of asphalt impregnated creped paper. Grooves running along the width of sheet.
- E. Polyethylene Coated Copper: Copper sheet ASTM B370, weighing 1 Kg/m² (3 oz/sf) bonded between two layers of (two mil) thick polyethylene sheet.
- F. Aluminum Sheet: ASTM B209, alloy 3003-H14 except alloy used for color anodized aluminum shall be as required to produce specified color. Alloy required to produce specified color shall have the same structural properties as alloy 3003-H14.
- G. Galvanized Sheet: ASTM, A653.
- H. Nonreinforced, Elastomeric Sheeting: Elastomeric substances reduced to thermoplastic state and extruded into continuous homogenous sheet (0.056 inch) thick. Sheeting shall have not less than 7 MPa (1,000 psi) tensile strength and not more than seven percent tension-set at 50 percent elongation when tested in accordance with ASTM D412. Sheeting shall show no cracking or flaking when bent through 180 degrees over a 1 mm (1/32 inch) diameter mandrel and then bent at same point over same size mandrel in opposite direction through 360 degrees at temperature of -30°C (-20 °F).

2.2 FLASHING ACCESSORIES

- A. Solder: ASTM B32; flux type and alloy composition as required for use with metals to be soldered.
- B. Rosin Paper: Fed-Spec. UU-B-790, Type I, Grade D, Style 1b, Rosin-sized sheathing paper, weighing approximately 3 Kg/10 m² (6 lbs/100 sf).
- C. Bituminous Paint: ASTM D1187, Type I.
- D. Fasteners:

1. Use copper, copper alloy, bronze, brass, or stainless steel for copper and copper clad stainless steel, and stainless steel for stainless steel and aluminum alloy. Use galvanized steel or stainless steel for galvanized steel.
2. Nails:
 - a. Minimum diameter for copper nails: 3 mm (0.109 inch).
 - b. Minimum diameter for aluminum nails 3 mm (0.105 inch).
 - c. Minimum diameter for stainless steel nails: 2 mm (0.095 inch) and annular threaded.
 - d. Length to provide not less than 22 mm (7/8 inch) penetration into anchorage.
3. Rivets: Not less than 3 mm (1/8 inch) diameter.
4. Expansion Shields: Fed Spec A-A-1925A.
- E. Sealant: As specified in Section 07 92 00, JOINT SEALANTS for exterior locations.
- F. Insect Screening: ASTM D3656, 18 by 18 regular mesh.
- G. Roof Cement: ASTM D4586.

2.3 SHEET METAL THICKNESS

- A. Except as otherwise shown or specified use thickness or weight of sheet metal as follows:
- B. Concealed Locations (Built into Construction):
 1. Copper: 30g (10 oz) minimum 0.33 mm (0.013 inch thick).
 2. Stainless steel: 0.25 mm (0.010 inch) thick.
 3. Copper clad stainless steel: 0.25 mm (0.010 inch) thick.
 4. Galvanized steel: 0.5 mm (0.021 inch) thick.
- C. Exposed Locations:
 1. Copper: 0.4 Kg (16 oz).
 2. Stainless steel: 0.4 mm (0.015 inch).
 3. Copper clad stainless steel: 0.4 mm (0.015 inch).
- D. Thickness of aluminum or galvanized steel is specified with each item.

2.4 FABRICATION, GENERAL

- A. Jointing:
 1. In general, copper, stainless steel and copper clad stainless steel joints, except expansion and contraction joints, shall be locked and soldered.

2. Jointing of copper over 0.5 Kg (20 oz) weight or stainless steel over 0.45 mm (0.018 inch) thick shall be done by lapping, riveting and soldering.
 3. Joints shall conform to following requirements:
 - a. Flat-lock joints shall finish not less than 19 mm (3/4 inch) wide.
 - b. Lap joints subject to stress shall finish not less than 25 mm (one inch) wide and shall be soldered and riveted.
 - c. Unsoldered lap joints shall finish not less than 100 mm (4 inches) wide.
 4. Flat and lap joints shall be made in direction of flow.
 5. Edges of bituminous coated copper, copper covered paper, nonreinforced elastomeric sheeting and polyethylene coated copper shall be jointed by lapping not less than 100 mm (4 inches) in the direction of flow and cementing with asphalt roof cement or sealant as required by the manufacturer's printed instructions.
 6. Soldering:
 - a. Pre tin both mating surfaces with solder for a width not less than 38 mm (1 1/2 inches) of uncoated copper, stainless steel, and copper clad stainless steel.
 - b. Wire brush to produce a bright surface before soldering lead coated copper.
 - c. Treat in accordance with metal producers recommendations other sheet metal required to be soldered.
 - d. Completely remove acid and flux after soldering is completed.
- B. Expansion and Contraction Joints:
1. Fabricate in accordance with the Architectural Sheet Metal Manual recommendations for expansion and contraction of sheet metal work in continuous runs.
 2. Space joints as shown or as specified.
 3. Space expansion and contraction joints for copper, stainless steel, and copper clad stainless steel at intervals not exceeding 7200 mm (24 feet).
 4. Space expansion and contraction joints for aluminum at intervals not exceeding 5400 mm (18 feet), except do not exceed 3000 mm (10 feet) for gravel stops and fascia-cant systems.

5. Fabricate slip-type or loose locked joints and fill with sealant unless otherwise specified.
6. Fabricate joint covers of same thickness material as sheet metal served.

C. Cleats:

1. Fabricate cleats to secure flashings and sheet metal work over 300 mm (12 inches) wide and where specified.
2. Provide cleats for maximum spacing of 300 mm (12 inch) centers unless specified otherwise.
3. Form cleats of same metal and weights or thickness as the sheet metal being installed unless specified otherwise.
4. Fabricate cleats from 50 mm (2 inch) wide strip. Form end with not less than 19 mm (3/4 inch) wide loose lock to item for anchorage. Form other end of length to receive nails free of item to be anchored and end edge to be folded over and cover nail heads.

D. Edge Strips or Continuous Cleats:

1. Fabricate continuous edge strips where shown and specified to secure loose edges of the sheet metal work.
2. Except as otherwise specified, fabricate edge strips or minimum 0.6 mm (0.024 inch) thick stainless steel or 1.25 mm (0.050 inch) thick aluminum.
3. Use material compatible with sheet metal to be secured by the edge strip.
4. Fabricate in 3000 mm (10 feet) maximum lengths with not less than 19 mm (3/4 inch) loose lock into metal secured by edge strip.
5. Fabricate Strips for fascia anchorage to extend below the supporting wood construction to form a drip and to allow the flashing to be hooked over the lower edge at least 19 mm (3/4-inch).
6. Fabricate anchor edge maximum width of 75 mm (3 inches) or of sufficient width to provide adequate bearing area to insure a rigid installation using 0.8 mm (0.031 inch) thick stainless steel or 1.6 mm (0.0625 inch) thick aluminum.

E. Drips:

1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge

- back 13 mm (1/2 inch) and bending out 45 degrees from vertical to carry water away from the wall.
2. Form drip to provide hook to engage cleat or edge strip for fastening for not less than 19 mm (3/4 inch) loose lock where shown.
- F. Edges:
1. Edges of flashings concealed in masonry joints opposite drain side shall be turned up 6 mm (1/4 inch) to form dam, unless otherwise specified or shown otherwise.
 2. Finish exposed edges of flashing with a 6 mm (1/4 inch) hem formed by folding edge of flashing back on itself when not hooked to edge strip or cleat. Use 6 mm (1/4 inch) minimum penetration beyond wall face with drip for through-wall flashing exposed edge.
 3. All metal roof edges shall meet requirements of IBC, current edition.
- G. Metal Options:
1. Where options are permitted for different metals use only one metal throughout.
 2. Stainless steel may be used in concealed locations for fasteners of other metals exposed to view.

2.5 FINISHES (MATCH EXISTING)

- A. Use same finish on adjacent metal or components and exposed metal surfaces unless specified or shown otherwise.
- B. In accordance with NAAMM Metal Finishes Manual AMP 500, unless otherwise specified.
- C. Finish exposed metal surfaces as follows, unless specified otherwise:
 1. Copper: Mill finish.
 2. Stainless Steel: Finish No. 2B or 2D.
 3. Aluminum:
 - a. Clear Finish: AA-C22A41 medium matte, clear anodic coating, Class 1 Architectural, 18 mm (0.7 mils) thick.
 - b. Colored Finish: AA-C22A42 (anodized) or AA-C22A44 (electrolytically deposited metallic compound) medium matte, integrally colored coating, Class 1 Architectural, 18 mm (0.7 mils) thick. Dyes will not be accepted.
 - c. Fluorocarbon Finish: AAMA 620, high performance organic coating.

- d. Mill finish.
- 4. Steel and Galvanized Steel:
 - a. Finish painted under Section 09 91 00, PAINTING unless specified as prefinished item.
 - b. Manufacturer's finish:
 - 1) Baked on prime coat over a phosphate coating.
 - 2) Baked-on prime and finish coat over a phosphate coating.
 - 3) Fluorocarbon Finish: AAMA 621, high performance organic coating.

2.6 THROUGH-WALL FLASHINGS

- A. Form through-wall flashing to provide a mechanical bond or key against lateral movement in all directions. Install a sheet having 2 mm (1/16 inch) deep transverse channels spaced four to every 25 mm (one inch), or ribbed diagonal pattern, or having other deformation unless specified otherwise.
 - 1. Fabricate in not less than 2400 mm (8 feet) lengths; 3000 mm (10 feet) maximum lengths.
 - 2. Fabricate so keying nests at overlaps.
- B. For Masonry Work When Concealed Except for Drip:
 - 1. Either copper, stainless steel, or copper clad stainless steel.
 - 2. Form an integral dam at least 5 mm (3/16 inch) high at back edge.
 - 3. Form exposed portions of flashing with drip, approximately 6 mm (1/4 inch) projection beyond wall face.
- C. For Masonry Work When Exposed Edge Forms a Receiver for Counter Flashing:
 - 1. Use same metal and thickness as counter flashing.
 - 2. Form an integral dam at least 5 mm (3/16 inch) high at back edge.
 - 3. Form exposed portion as snap lock receiver for counter flashing upper edge.
- D. For Flashing at Architectural Precast Concrete Panels or Stone Panels.
 - 1. Use plan flat sheet of stainless steel.
 - 2. Form exposed portions with drip as specified or receiver.
- E. Window Sill Flashing and Lintel Flashing:
 - 1. Use either copper, stainless steel, copper clad stainless steel plane flat sheet, or nonreinforced elastomeric sheeting, bituminous coated copper, copper covered paper, or polyethylene coated copper.

2. Fabricate flashing at ends with folded corners to turn up 5 mm (3/16 inch) in first vertical masonry joint beyond masonry opening.
3. Turn up back edge as shown.
4. Form exposed portion with drip as specified or receiver.

F. Door Sill Flashing:

1. Where concealed, use either 0.5 Kg (20 oz) copper, 0.5 mm (0.018 inch) thick stainless steel, or 0.5 mm (0.018 inch) thick copper clad stainless steel.
2. Where shown on drawings as combined counter flashing under threshold, sill plate, door sill, or where subject to foot traffic, use either 0.6 Kg (24 ounce) copper, 0.6 mm (0.024 inch) stainless steel, or 0.6 mm (0.024 inch) thick stainless steel.
3. Fabricate flashing at ends to turn up 5 mm (3/16 inch) in first vertical masonry joint beyond masonry opening with folded corners.

2.7 BASE FLASHING

- A. Use metal base flashing at vertical surfaces intersecting built-up roofing without cant strips or where shown.
 1. Use either copper, or stainless steel, thickness specified unless specified otherwise.
 2. When flashing is over 250 mm (10 inches) in vertical height or horizontal width use either 0.5 Kg (20 oz) copper or 0.5 mm (0.018 inch) stainless steel.
 3. Use stainless steel at aluminum roof curbs where flashing contacts the aluminum.
 4. Use either copper, or stainless steel at pipe flashings.
- B. Fabricate metal base flashing up vertical surfaces not less than 200 mm (8 inch) nor more than 400 mm (16 inch).
- C. Fabricate roof flange not less than 100 mm (4 inches) wide unless shown otherwise. When base flashing length exceeds 2400 mm (8 feet) form flange edge with 13 mm (1/2 inch) hem to receive cleats.
- D. Form base flashing bent from strip except pipe flashing. Fabricate ends for riveted soldered lap seam joints. Fabricate expansion joint ends as specified.
- E. Pipe Flashing: (Other than engine exhaust or flue stack)
 1. Fabricate roof flange not less than 100 mm (4 inches) beyond sleeve on all sides.

2. Extend sleeve up and around pipe and flange out at bottom not less than 13 mm (1/2 inch) and solder to flange and sleeve seam to make watertight.
3. At low pipes 200 mm (8 inch) to 450 mm (18 inch) above roof:
 - a. Form top of sleeve to turn down into the pipe at least 25 mm (one inch).
 - b. Allow for loose fit around and into the pipe.
4. At high pipes and pipes with goosenecks or other obstructions which would prevent turning the flashing down into the pipe:
 - a. Extend sleeve up not less than 300 mm (12 inch) above roofing.
 - b. Allow for loose fit around pipe.

2.8 COUNTERFLASHING (CAP FLASHING OR HOODS)

- A. Either copper or stainless steel, unless specified otherwise.
- B. Fabricate to lap base flashing a minimum of 100 mm (4 inches) with drip:
 1. Form lock seams for outside corners. Allow for lap joints at ends and inside corners.
 2. In general, form flashing in lengths not less than 2400 mm (8 feet) and not more than 3000 mm (10 feet).
 3. Two-piece, lock in type flashing may be used in-lieu-of one piece counter-flashing.
 4. Manufactured assemblies may be used.
 5. Where counterflashing is installed at new work use an integral flange at the top designed to be extended into the masonry joint or reglet in concrete.
 6. Where counterflashing is installed at existing work use surface applied type, formed to provide a space for the application of sealant at the top edge.
- C. One-piece Counterflashing:
 1. Back edge turned up and fabricate to lock into reglet in concrete.
 2. Upper edge formed to extend full depth of masonry unit in mortar joint with back edge turned up 6 mm (1/4 inch).
- D. Two-Piece Counterflashing:
 1. Receiver to extend into masonry wall depth of masonry unit with back edge turned up 6 mm (1/4 inch) and exposed edge designed to receive and lock counterflashing upper edge when inserted.

2. Counterflashing upper edge designed to snap lock into receiver.
- E. Surface Mounted Counterflashing; one or two piece:
1. Use at existing or new surfaces where flashing can not be inserted in vertical surface.
 2. One piece fabricate upper edge folded double for 65 mm (2 1/2 inches) with top 19 mm (3/4 inch) bent out to form "V" joint sealant pocket with vertical surface. Perforate flat double area against vertical surface with horizontally slotted fastener holes at 400 mm (16 inch) centers between end holes. Option: One piece surface mounted counter-flashing (cap flashing) may be used. Fabricate as detailed on Plate 51 of SMACNA Architectural Sheet Metal Manual.
 3. Two pieces: Fabricate upper edge to lock into surface mounted receiver. Fabricate receiver joint sealant pocket on upper edge and lower edge to receive counterflashing, with slotted fastener holes at 400 mm (16 inch) centers between upper and lower edge.
- F. Pipe Counterflashing:
1. Form flashing for water-tight umbrella with upper portion against pipe to receive a draw band and upper edge to form a "V" joint sealant receiver approximately 19 mm (3/4 inch) deep.
 2. Fabricate 100 mm (4 inch) over lap at end.
 3. Fabricate draw band of same metal as counter flashing. Use 0.6 Kg (24 oz) copper or 0.33 mm (0.013 inch) thick stainless steel or copper coated stainless steel.
 4. Use stainless steel bolt on draw band tightening assembly.
 5. Vent pipe counter flashing may be fabricated to omit draw band and turn down 25 mm (one inch) inside vent pipe.
- G. Where vented edge decks intersect vertical surfaces, form in one piece, shape to slope down to a point level with and in front of edge-set notched plank; then, down vertically, overlapping base flashing.

2.9 GRAVEL STOPS (NOT USED)**2.10 BITUMEN STOPS (NOT USED)****2.11 HANGING GUTTERS (NOT USED)****2.12 CONDUCTORS (DOWNSPOUTS) (NOT USED)****2.13 SPLASHPANS (NOT USED)****2.14 REGLETS**

- A. Fabricate reglets of one of the following materials:
 - 1. 0.4 Kg (16 ounce) copper.
 - 2. Stainless steel, not less than 0.3 mm (0.012 inch) thick.
 - 3. Plastic coated extruded aluminum, not less than 1.4 mm (0.055 inch) thick prefilled with butyl rubber sealer and complete with plastic wedges inserted at 1000 mm (40 inches) on centers.
 - 4. Plastic, ASTM D1784, Type II, not less than 2 mm (0.075 inch) thick.
- B. Fill open-type reglets with fiberboard or other suitable separator, to prevent crushing of the slot during installation.
- C. Bend edges of reglets for setting into concrete to an angle of not less than 45 degrees, and make wide enough to provide firm anchorage in the concrete.
- D. Fabricate reglets for building into horizontal masonry mortar joints not less than 19 mm (3/4 inch) deep, nor more than 25 mm (one inch) deep.
- E. Fabricate mitered corners, fittings, and special shapes as may be required by details.
- F. Reglets for concrete may be formed to receive flashing and have a 10 mm (3/8 inch), 45 degree snap lock.

2.15 INSULATED EXPANSION JOINT COVERS

- A. Either type optional, use only one type throughout.
- B. Types:
 - 1. Construct of two preformed, stainless steel strips, not less than 0.4 mm (0.015 inch) thick, mechanically and adhesively bonded to both sides of a 2 mm (1/16 inch) thick neoprene or butyl sheet, or to a 0.4 mm (32 mil) thick reinforced chlorinated polyethylene sheet. Adhesively attach a 10 mm (3/8 inch) thick sheet of closed

- cell, neoprene foam insulation, to the underside of the neoprene, butyl, or chlorinated polyethylene sheet.
2. Constructed of a 2 mm (1/16 inch) thick vinyl sheet, flanged at both sides with stainless steel strips not less than 0.4 mm (0.015 inch) thick. Vinyl sheet locked and encased by the stainless steel strip and prepunched for nailing. A 10 mm (3/8 inch) thick closed cell polyvinyl chloride foam insulating strip shall be heat laminated to the underside of the vinyl sheet between the stainless steel strips.
- C. Expansion joint covers shall have factory fabricated mitered corners, crossing tees, and other necessary accessories. Furnish in the longest available lengths.
 - D. Metal flange of sufficient width to extend over the top of the curb and down curb sides 50 mm (2 inches) with hemmed edge for lock to edge strip.

2.16 ENGINE EXHAUST PIPE OR FLUE OR STACK FLASHING

- A. Flashing at penetrations through roofing shall consist of a metal collar, sheet metal flashing sleeve and hood. Do not allow wood in contact with collar.
- B. Fabricate collar with roof flange of 1.2 mm (0.047 inch) minimum thick black iron or galvanized steel sheet.
 1. Fabricate inside diameter of collar 100 mm (4 inches) larger than the outside diameter of the item penetration the roofing.
 2. Extend collar height from structural roof deck to not less than 350 mm (14 inches) above roof surface.
 3. Fabricate collar roof flange not less than 100 mm (4 inches) wide.
 4. Option: Collar may be of steel tubing 3 mm (0.125 inch) minimum wall thickness, with not less than four, 50 mm x 100 mm x 3 mm (2 inch by 4 inch by 0.125 inch) thick tabs bottom edge evenly spaced around tube in lieu of continuous roof flange. Full butt weld joints of collar.
- C. Fabricate sleeve base flashing with roof flange of either copper, stainless steel, or copper clad stainless steel.
 1. Fabricate sleeve roof flange not less than 100 mm (4 inches) wide.
 2. Extend sleeve around collar up to top of collar.
 3. Flange bottom of sleeve out not less than 13 mm (1/24 inch) and soldered to 100 mm (4 inch) wide flange to make watertight.

4. Fabricate interior diameter 50 mm (2 inch) greater than collar.
- D. Fabricate hood counter flashing from same material and thickness as sleeve.
 1. Fabricate the same as pipe counter flashing except allow not less than 100 mm (4 inch) lap below top of sleeve and to form vent space minimum of 100 mm (4 inch) wide.
 2. Hem bottom edge of hood 13 mm (1/2 inch).
 3. Provide a 50 mm (2 inch) deep drawband.
- E. Fabricate insect screen closure between sleeve and hood. Secure screen to sleeve with sheet metal screws.

2.17 SCUPPERS (NOT USED)

2.18 GOOSENECK ROOF VENTILATORS

- A. Form of 1.3 mm (0.0508 inch) thick sheet aluminum, reinforce as necessary for rigidity, stiffness, and connection to curb, and to be watertight.
 1. Form lower-edge to sleeve to curb.
 2. Curb:
 - a. Form for 100 mm (4 inch) high sleeve to ventilator.
 - b. Form for concealed anchorage to structural curb and to bear on structural curb.
 - c. Form bottom edge of curb as counterflashing to lap base flashing.
- B. Provide open end with 1.6 mm (16 gage), stainless steel wire guard of 13 mm (1/2 inch) square mesh.
 1. Construct suitable aluminum angle frame to retain wire guard.
 2. Rivet angle frame to end of gooseneck.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install flashing and sheet metal items as shown in Sheet Metal and Air Conditioning Contractors National Association, Inc., publication, ARCHITECTURAL SHEET METAL MANUAL, except as otherwise shown or specified.
 2. Apply Sealant as specified in Section 07 92 00, JOINT SEALANTS.

3. Apply sheet metal and other flashing material to surfaces which are smooth, sound, clean, dry and free from defects that might affect the application.
4. Remove projections which would puncture the materials and fill holes and depressions with material compatible with the substrate. Cover holes or cracks in wood wider than 6 mm (1/4 inch) with sheet metal compatible with the roofing and flashing material used.
5. Coordinate with masonry work for the application of a skim coat of mortar to surfaces of unit masonry to receive flashing material before the application of flashing.
6. Apply a layer of 7 Kg (15 pound) saturated felt followed by a layer of rosin paper to wood surfaces to be covered with copper. Lap each ply 50 mm (2 inch) with the slope and nail with large headed copper nails.
7. Confine direct nailing of sheet metal to strips 300 mm (12 inch) or less wide. Nail flashing along one edge only. Space nail not over 100 mm (4 inches) on center unless specified otherwise.
8. Install bolts, rivets, and screws where indicated, specified, or required in accordance with the SMACNA Sheet Metal Manual. Space rivets at 75 mm (3 inch) on centers in two rows in a staggered position. Use neoprene washers under fastener heads when fastener head is exposed.
9. Coordinate with roofing work for the installation of metal base flashings and other metal items having roof flanges for anchorage and watertight installation.
10. Nail continuous cleats on 75 mm (3 inch) on centers in two rows in a staggered position.
11. Nail individual cleats with two nails and bend end tab over nail heads. Lock other end of cleat into hemmed edge.
12. Install flashings in conjunction with other trades so that flashings are inserted in other materials and joined together to provide a water tight installation.
13. Where required to prevent galvanic action between dissimilar metal isolate the contact areas of dissimilar metal with sheet lead, waterproof building paper, or a coat of bituminous paint.

14. Isolate aluminum in contact with dissimilar metals others than stainless steel, white bronze or other metal compatible with aluminum by:
 - a. Paint dissimilar metal with a prime coat of zinc-chromate or other suitable primer, followed by two coats of aluminum paint.
 - b. Paint dissimilar metal with a coat of bituminous paint.
 - c. Apply an approved caulking material between aluminum and dissimilar metal.
15. Paint aluminum in contact with or built into mortar, concrete, plaster, or other masonry materials with a coat of bituminous paint.
16. Paint aluminum in contact with absorptive materials that may become repeatedly wet with two coats of bituminous paint or two coats of aluminum paint.
17. Bitumen Stops:
 - a. Install bitumen stops for built-up roof opening penetrations through deck and at formed sheet metal gravel stops.
 - b. Nail leg of bitumen stop at 300 mm (12 inch) intervals to nailing strip at roof edge before roofing material is installed.

3.2 THROUGH-WALL FLASHING

A. General:

1. Install continuous through-wall flashing between top of concrete foundation walls and bottom of masonry building walls; at top of concrete floors; under masonry, concrete, or stone copings and elsewhere as shown.
2. Where exposed portions are used as a counterflashings, lap base flashings at least 100 mm (4 inches) and use thickness of metal as specified for exposed locations.
3. Exposed edge of flashing may be formed as a receiver for two piece counter flashing as specified.
4. Terminate exterior edge beyond face of wall approximately 6 mm (1/4 inch) with drip edge where not part of counter flashing.
5. Turn back edge up 6 mm (1/4 inch) unless noted otherwise where flashing terminates in mortar joint or hollow masonry unit joint.
6. Terminate interior raised edge in masonry backup unit approximately 38 mm (1 1/2 inch) into unit unless shown otherwise.

7. Under copings terminate both edges beyond face of wall approximately 6 mm (1/4 inch) with drip edge.
 8. Lap end joints at least two corrugations, but not less than 100 mm (4 inches). Seal laps with sealant.
 9. Where dowels, reinforcing bars and fastening devices penetrate flashing, seal penetration with sealing compound. Sealing compound is specified in Section 07 92 00, JOINT SEALANTS.
 10. Coordinate with other work to set in a bed of mortar above and below flashing so that total thickness of the two layers of mortar and flashing are same as regular mortar joint.
 11. Where ends of flashing terminate turn ends up 25 mm (1 inch) and fold corners to form dam extending to wall face in vertical mortar or veneer joint.
 12. Turn flashing up not less than 200 mm (8 inch) between masonry or behind exterior veneer.
 13. When flashing terminates in reglet extend flashing full depth into reglet and secure with lead or plastic wedges spaced 150 mm (6 inch) on center.
 14. Continue flashing around columns:
 - a. Where flashing cannot be inserted in column reglet hold flashing vertical leg against column.
 - b. Counterflash top edge with 75 mm (3 inch) wide strip of saturated cotton unless shown otherwise. Secure cotton strip with roof cement to column. Lap base flashing with cotton strip 38 mm (1 1/2 inch).
- B. Flashing at Top of Concrete Foundation Walls Where concrete is exposed. Turn up not less than 200 mm (8 inch) high and into masonry backup mortar joint or reglet in concrete backup as specified.
- C. Flashing at Top of Concrete Floors (except where shelf angles occur): Place flashing in horizontal masonry joint not less than 200 mm (8 inch) below floor slab and extend into backup masonry joint at floor slab 38 mm (1 1/2 inch).
- D. Flashing at Cavity Wall Construction: Where flashing occurs in cavity walls turn vertical portion up against backup under waterproofing, if any, into mortar joint. Turn up over insulation, if any, and horizontally through insulation into mortar joint.

E. Flashing at Veneer Walls:

1. Install near line of finish floors over shelf angles or where shown.
2. Turn up against sheathing.
3. At stud framing, hem top edge 19 mm (3/4 inch) and secure to each stud with stainless steel fasteners through sheathing.
4. At concrete backing, extend flashing into reglet as specified.
5. Coordinate with installation of waterproofing or asphalt felt for lap over top of flashing.

F. Lintel Flashing when not part of shelf angle flashing:

1. Install flashing full length of lintel to nearest vertical joint in masonry over veneer.
2. Turn ends up 25 mm (one inch) and fold corners to form dam and extend end to face of wall.
3. Turn back edge up to top of lintel; terminate back edge as specified for back-up wall.

G. Window Sill Flashing: (NOT USED)

H. Door Sill Flashing: (NOT USED)

- 1.

I. Flashing at Masonry, Stone, or Precast Concrete Copings:

1. Install flashing with drips on both wall faces unless shown otherwise.
2. Form penetration openings to fit tight against dowel or other item with edge turned up. Seal penetrations with sealant.

3.3 BASE FLASHING

A. Install where roof membrane type base flashing is not used and where shown.

1. Install flashing at intersections of roofs with vertical surfaces or at penetrations through roofs, to provide watertight construction.
2. Install metal flashings and accessories having flanges extending out on top of the built-up roofing before final bituminous coat and roof aggregate is applied.
3. Set flanges in heavy trowel coat of roof cement and nail through flanges into wood nailers over bituminous roofing.
4. Secure flange by nailing through roofing into wood blocking with nails spaced 75 mm (3 inch) on centers or, when flange over 100 mm (4 inch) wide terminate in a 13 mm (1/2 inch) folded edge anchored

- with cleats spaced 200 mm (8 inch) on center. Secure one end of cleat over nail heads. Lock other end into the seam.
- B. For long runs of base flashings install in lengths of not less than 2400 mm (8 feet) nor more than 3000 mm (ten feet). Install a 75 mm (3 inch) wide slip type, loose lock expansion joint filled with sealant in joints of base flashing sections over 2400 mm (8 feet) in length. Lock and solder corner joints at corners.
 - C. Extend base flashing up under counter flashing of roof specialties and accessories or equipment not less than 75 mm (3 inch).

3.4 COUNTERFLASHING (CAP FLASHING OR HOODS)

- A. General:
 - 1. Install counterflashing over and in conjunction with installation of base flashings, except as otherwise specified or shown.
 - 2. Install counterflashing to lap base flashings not less than 100 mm (4 inch).
 - 3. Install upper edge or top of counterflashing not less than 225 mm (9 inch) above top of the roofing.
 - 4. Lap joints not less than 100 mm (4 inch). Stagger joints with relation to metal base flashing joints.
 - 5. Use surface applied counterflashing on existing surfaces and new work where not possible to integrate into item.
 - 6. When fastening to concrete or masonry, use screws driven in expansion shields set in concrete or masonry. Use screws to wood and sheet metal. Set fasteners in mortar joints of masonry work.
- B. One Piece Counterflashing:
 - 1. Where flashing is installed at new masonry, coordinate to insure proper height, embed in mortar, and end lap.
 - 2. Where flashing is installed in reglet in concrete insert upper edge into reglet. Hold flashing in place with lead wedges spaced not more than 200 mm (8 inch) apart. Fill joint with sealant.
 - 3. Where flashing is surface mounted on flat surfaces.
 - a. When top edge is double folded anchor flat portion below sealant "V" joint with fasteners spaced not over 400 mm (16 inch) on center:
 - 1) Locate fasteners in masonry mortar joints.
 - 2) Use screws to sheet metal or wood.

- b. Fill joint at top with sealant.
- 4. Where flashing or hood is mounted on pipe.
 - a. Secure with draw band tight against pipe.
 - b. Set hood and secure to pipe with a one by 25 mm x 3 mm (1 x 1/8 inch) bolt on stainless steel draw band type clamp, or a stainless worm gear type clamp.
 - c. Completely fill joint at top with sealant.
- C. Two-Piece Counterflashing:
 - 1. Where receiver is installed at new masonry coordinate to insure proper height, embed in mortar, and lap.
 - 2. Surface applied type receiver:
 - a. Secure to face construction in accordance, with manufacturers instructions.
 - b. Completely fill space at the top edge of receiver with sealant.
 - 3. Insert counter flashing in receiver in accordance with fabricator or manufacturer's instructions and to fit tight against base flashing.
- D. Where vented edge occur install so lower edge of counterflashing is against base flashing.
- E. When counter flashing is a component of other flashing install as shown.

3.5 REGLETS

- A. Install reglets in a manner to provide a watertight installation.
- B. Locate reglets not less than 225 mm (9 inch) nor more than 400 mm (16 inch) above roofing, and not less than 125 mm (5 inch) nor more than 325 mm (13 inch) above cant strip.
- C. Butt and align end joints or each section of reglet and securely hold in position until concrete or mortar are hardened:
 - 1. Coordinate reglets for anchorage into concrete with formwork construction.
 - 2. Coordinate reglets for masonry to locate horizontally into mortar joints.

3.6 GRAVEL STOPS (NOT USED)

3.7 COPINGS (NOT USED)

3.8 EXPANSION JOINT COVERS, INSULATED (NOT USED)

3.9 ENGINE EXHAUST PIPE OR STACK FLASHING

- A. Set collar where shown and secure roof tabs or flange of collar to structural deck with 13 mm (1/2 inch) diameter bolts.
- B. Set flange of sleeve base flashing not less than 100 mm (4 inch) beyond collar on all sides as specified for base flashing.
- C. Install hood to above the top of the sleeve 50 mm (2 inch) and to extend from sleeve same distance as space between collar and sleeve beyond edge not sleeve:
 - 1. Install insect screen to fit between bottom edge of hood and side of sleeve.
 - 2. Set collar of hood in high temperature sealant and secure with one by 3 mm (1/8 inch) bolt on stainless steel draw band type, or stainless steel worm gear type clamp. Install sealant at top of head.

3.10 HANGING GUTTERS (NOT USED)

3.11 CONDUCTORS (DOWNSPOUTS) (NOT USED)

3.12 SPLASH PANS (NOT USED)

3.13 GOOSENECK ROOF VENTILATORS

- A. Install on structural curb not less than 200 mm (8 inch) high above roof surface.
- B. Securely anchor ventilator curb to structural curb with fasteners spaced not over 300 mm (12 inch) on center.
- C. Anchor gooseneck to curb with screws having nonprene washers at 150 mm (6 inch) on center.

- - - E N D - - -

SECTION 07 84 00
FIRESTOPPING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Provide UL or equivalent approved firestopping system for the closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction.
- B. Provide UL or equivalent approved firestopping system for the closure of openings in walls against penetration of gases or smoke in smoke partitions.

1.2 RELATED WORK:

- A. Sustainable Design Requirements: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- B. 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. Sustainable Design Submittals, as described below:
 - 1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.
- C. Installer qualifications.
- D. Inspector qualifications.
- E. Manufacturers literature, data, and installation instructions for types of firestopping and smoke stopping used.
- F. List of FM, UL, or WH classification number of systems installed.
- G. Certified laboratory test reports for ASTM E814 tests for systems not listed by FM, UL, or WH proposed for use.
- H. Submit certificates from manufacturer attesting that firestopping materials comply with the specified requirements.

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 QUALITY ASSURANCE:

- A. FM, UL, or WH or other approved laboratory tested products will be acceptable.

- B. **Installer Qualifications:** A firm that has been approved by FM Global according to FM Global 4991 or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements." Submit qualification data.
- C. **Inspector Qualifications:** Contractor to engage a qualified inspector to perform inspections and final reports. The inspector to meet the criteria contained in ASTM E699 for agencies involved in quality assurance and to have a minimum of two years' experience in construction field inspections of firestopping systems, products, and assemblies. The inspector to be completely independent of, and divested from, the Contractor, the installer, the manufacturer, and the supplier of material or item being inspected. Submit inspector qualifications.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. **ASTM International (ASTM):**
- E84-14Surface Burning Characteristics of Building
Materials
- E699-09Standard Practice for Evaluation of Agencies
Involved in Testing, Quality Assurance, and
Evaluating of Building Components
- E814-13aFire Tests of Through-Penetration Fire Stops
- E2174-14Standard Practice for On-Site Inspection of
Installed Firestops
- E2393-10aStandard Practice for On-Site Inspection of
Installed Fire Resistive Joint Systems and
Perimeter Fire Barriers
- C. **FM Global (FM):**
- Annual Issue Approval Guide Building Materials
- 4991-13Approval of Firestop Contractors
- D. **Underwriters Laboratories, Inc. (UL):**
- Annual Issue Building Materials Directory
- Annual Issue Fire Resistance Directory
- 723-10(2008)Standard for Test for Surface Burning
Characteristics of Building Materials
- 1479-04(R2014)Fire Tests of Through-Penetration Firestops
- E. **Intertek Testing Services - Warnock Hersey (ITS-WH):**

Annual Issue Certification Listings

F. Environmental Protection Agency (EPA):

40 CFR 59(2014)National Volatile Organic Compound Emission
Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 FIRESTOP SYSTEMS:

- A. Provide 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. Firestop systems to accommodate building movements without impairing their integrity.
- 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 101 mm (4 in.) nominal pipe or 0.01 sq. m (16 sq. in.) in overall cross sectional area.
- C. Firestop sealants used for firestopping or smoke sealing to have the following properties:
1. Contain no flammable or toxic solvents.
 2. Release 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 installed in exposed areas, capable of being sanded and finished with similar surface treatments as used on the surrounding wall or floor surface.
 5. VOC Content: Firestopping sealants and sealant primers to comply with the following limits for VOC content when calculated according to 40 CFR 59, (EPA Method 24):
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
- D. Firestopping system or devices used for penetrations by glass pipe, plastic pipe or conduits, unenclosed cables, or other non-metallic materials to 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.
- E. Maximum flame spread of 25 and smoke development of 50 when tested in accordance with ASTM E84 or UL 723. Material to be an approved firestopping material as listed in UL Fire Resistance Directory or by a nationally recognized testing laboratory.
- F. FM, UL, or WH rated or tested by an approved laboratory in accordance with ASTM E814.
- G. Materials to be nontoxic and noncarcinogen at all stages of application or during fire conditions and to not contain hazardous chemicals. Provide firestop material that is free from Ethylene Glycol, PCB, MEK, and asbestos.
- H. For firestopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 2. For floor penetrations with annular spaces exceeding 101 mm (4 in.) or more in width and exposed to possible loading and traffic, provide firestop systems capable of supporting the floor loads involved either by installing floor plates or by other means acceptable to the firestop manufacturer.
 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

2.2 SMOKE STOPPING IN SMOKE PARTITIONS:

- A. Provide silicone sealant in smoke partitions as specified in Section 07 92 00, JOINT SEALANTS.
- B. Provide mineral fiber filler and bond breaker behind sealant.
- C. Sealants to have a maximum flame spread of 25 and smoke developed of 50 when tested in accordance with ASTM 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:**

- A. Submit product data and installation instructions, as required by article, submittals, after an on-site examination of areas to receive firestopping.
- B. Examine substrates and conditions with installer present for compliance with requirements for opening configuration, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION:

- A. Remove dirt, grease, oil, laitance and form-release agents from concrete, loose materials, or other substances that prevent adherence and bonding or application of the firestopping or smoke stopping materials.
- B. Remove insulation on insulated pipe for a distance of 150 mm (6 inches) on each 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.
- C. Prime substrates where required by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- D. Masking Tape: Apply masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed upon completion of work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestopping materials. Remove tape as soon as it is possible to do so without disturbing seal of firestopping with substrates.

3.3 INSTALLATION:

- A. Do not begin firestopping 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:

- A. As work on each floor is completed, remove materials, litter, and debris.
- B. Clean up spills of liquid type materials.
- C. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses by methods and with cleaning materials approved by manufacturers of firestopping products and of products in which opening and joints occur.
- D. Protect firestopping during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestopping immediately and install new materials to provide firestopping complying with specified requirements.

3.5 INSPECTIONS AND ACCEPTANCE OF WORK:

- A. Do not conceal or enclose firestop assemblies until inspection is complete and approved by the Contracting Officer Representative (COR).
- B. Furnish service of approved inspector to inspect firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results. Submit written reports indicating locations of and types of penetrations and type of firestopping used at each location; type is to be recorded by UL listed printed numbers.

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SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section covers interior and exterior sealant and their application, wherever required for complete installation of building materials or systems.

1.2 RELATED WORK (INCLUDING BUT NOT LIMITED TO THE FOLLOWING):

- A. Masonry Control and Expansion Joint: Section 04 20 00, UNIT MASONRY.
B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

1.3 QUALITY ASSURANCE:

- A. Installer Qualifications: An experienced installer with a minimum of three (3) years' experience and 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. Submit qualification.
- B. Source Limitations: Obtain each type of joint sealant through one (1) 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 other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.
- D. Lab Tests: Submit samples of materials that will be in contact or affect joint sealants to joint sealant manufacturers for tests as follows:
1. Adhesion Testing: Before installing elastomeric sealants, test their adhesion to protect joint substrates according to the method in ASTM C794 to determine if primer or other specific joint preparation techniques are required.

2. Compatibility Testing: Before installing elastomeric sealants, determine compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Perform testing per ASTM C1248 on interior and exterior sealants to determine if sealants or primers will stain adjacent surfaces. No sealant work is to start until results of these tests have been submitted to the Contracting Officer Representative (COR) and the COR has given written approval to proceed with the work.
4. 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.

1.4 CERTIFICATION:

- A. Contractor is to submit to the COR written certification that joints are of the proper size and design, that the materials supplied are compatible with adjacent materials and backing, that the materials will properly perform to provide permanent watertight, airtight or vapor tight seals (as applicable), and that materials supplied meet specified performance requirements.

1.5 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Installer qualifications.
- C. Contractor certification.
- D. Manufacturer's installation instructions for each product used.
- E. Cured samples of exposed sealants for each color.
- F. Manufacturer's Literature and Data:
 1. Primers
 2. Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- G. Manufacturer warranty.

1.6 PROJECT CONDITIONS:

- A. Environmental Limitations:
 1. Do not proceed with installation of joint sealants under following conditions:

- a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C (40 degrees F).
- b. When joint substrates are wet.

B. Joint-Width Conditions:

- 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

C. Joint-Substrate Conditions:

- 1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.7 DELIVERY, HANDLING, AND STORAGE:

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

1.8 DEFINITIONS:

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Backing 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.

1.9 WARRANTY:

- A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".
- B. Manufacturer Warranty: Manufacturer shall warranty their sealant for a minimum of five (5) years from the date of installation and final acceptance by the Government. Submit manufacturer warranty.

1.10 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. ASTM International (ASTM):

- C509-06Elastomeric Cellular Preformed Gasket and Sealing Material
- C612-14Mineral Fiber Block and Board Thermal Insulation
- C717-14aStandard Terminology of Building Seals and Sealants
- C734-06 (R2012)Test Method for Low-Temperature Flexibility of Latex Sealants after Artificial Weathering
- C794-10Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
- C919-12.Use of Sealants in Acoustical Applications.
- C920-14aElastomeric Joint Sealants.
- C1021-08 (R2014)Laboratories Engaged in Testing of Building Sealants
- C1193-13Standard Guide for Use of Joint Sealants.
- C1248-08 (R2012)Test Method for Staining of Porous Substrate by Joint Sealants
- C1330-02 (R2013)Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
- C1521-13Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
- D217-10Test Methods for Cone Penetration of Lubricating Grease
- D1056-14Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
- E84-09Surface Burning Characteristics of Building Materials

C. Sealant, Waterproofing and Restoration Institute (SWRI).
The Professionals' Guide

D. Environmental Protection Agency (EPA):
40 CFR 59 (2014)National Volatile Organic Compound Emission Standards for Consumer and Commercial Products

PART 2 - PRODUCTS

2.1 SEALANTS:

A. Exterior Sealants:

1. Vertical surfaces, provide non-staining ASTM C920, Type S or M, Grade NS, Class 25, Use NT.
 2. Horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T.
 3. Provide location(s) of exterior sealant as follows:
 - a. Joints formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Provide sealant at exterior surfaces of exterior wall penetrations.
 - b. Metal to metal.
 - c. Masonry to masonry or stone.
 - d. Stone to stone.
 - e. Cast stone to cast stone.
 - f. Masonry expansion and control joints.
 - g. Wood to masonry.
 - h. Masonry joints where shelf angles occur.
 - i. Voids where items penetrate exterior walls.
 - j. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.
- B. Floor Joint Sealant:
1. ASTM C920, Type S or M, Grade P, Class 25, Use T.
 2. Provide location(s) of floor joint sealant as follows.
 - a. Seats of metal thresholds exterior doors.
 - b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.
- C. Interior Sealants:
1. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system are to comply with the following limits for VOC content when calculated according to 40 CFR 59, (EPA Method 24):
 - a. Architectural Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
 2. Vertical and Horizontal Surfaces: ASTM C920, Type S or M, Grade NS, Class 25, Use NT.

3. Food Service: Use a Vinyl Acetate Homopolymer, or other low VOC, non-toxic sealant approved for use in food preparation areas.
4. Provide location(s) of interior sealant as follows:
 - a. Typical narrow joint 6 mm, (1/4 inch) or less at walls and adjacent components.
 - b. Perimeter of doors, windows, access panels which adjoin concrete or masonry surfaces.
 - c. Interior surfaces of exterior wall penetrations.
 - d. Joints at masonry walls and columns, piers, concrete walls or exterior walls.
 - e. Perimeter of lead faced control windows and plaster or gypsum wallboard walls.
 - f. Exposed isolation joints at top of full height walls.
 - g. Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where nonplanar tile surfaces meet.
 - h. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.
 - i. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.

D. Acoustical Sealant:

1. Conforming to ASTM C919; flame spread of 25 or less; and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Acoustical sealant have a consistency of 250 to 310 when tested in accordance with ASTM D217; remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734; and be non-staining.
2. Provide location(s) of acoustical sealant as follows:
 - a. Exposed acoustical joint at sound rated partitions.
 - b. Concealed acoustic joints at sound rated partitions.
 - c. Joints where item pass-through sound rated partitions.

2.2 COLOR:

- A. Sealants used with exposed masonry are to match color of mortar joints.
- B. Sealants used with unpainted concrete are to match color of adjacent concrete.

- C. Color of sealants for other locations to be light gray or aluminum, unless otherwise indicated in construction documents.

2.3 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 or synthetic rubber (ASTM C509), nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32 degrees C (minus 26 degrees 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.

2.4 WEEPS: (NOT USED)

2.5 FILLER: (NOT USED)

2.6 PRIMER:

- A. As recommended by manufacturer of caulking or sealant material.
- B. Stain free type.

2.7 CLEANERS-NON POROUS SURFACES:

- A. Chemical cleaners compatible with sealant and acceptable to manufacturer of sealants and sealant backing material. Cleaners to be 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 (The Professionals' Guide).
- 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 but are not limited to 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. Nonporous surfaces include but are not limited to the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- C. Do not cut or damage joint edges.
- D. Apply non-staining 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 or as indicated by pre-construction joint sealant substrate test.
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. Avoid application to or spillage onto adjacent substrate surfaces.

3.3 BACKING INSTALLATION:

- A. Install backing 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 backing rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of backing rod and sealants.
- D. Install backing 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 backing rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two opposing surfaces.

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 degrees C and 38 degrees C (40 degrees and 100 degrees F).

2. Do not install 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 install 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 exposed joints to form smooth and uniform beds, with slightly concave surface conforming to joint configuration per Figure 5A in ASTM C1193 unless shown or specified otherwise in construction documents. Remove masking tape immediately after tooling of sealant and before sealant face starts to "skin" over. Remove any excess sealant from adjacent surfaces of joint, leaving the working in a clean finished condition.
 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. Submit test reports.
 11. Replace sealant which is damaged during construction process.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise. Take all necessary steps to prevent three-sided adhesion of sealants.
- C. Interior Sealants: 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 cutouts 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. 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.
- B. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

3.7 CLEANING:

- A. Fresh compound accidentally smeared on adjoining surfaces: Scrape off immediately and rub clean with a solvent as recommended by manufacturer of the adjacent material or if not otherwise indicated by the caulking or sealant manufacturer.
- B. Leave adjacent surfaces in a clean and unstained condition.

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SECTION 09 05 16
SUBSURFACE PREPARATION FOR FLOOR FINISHES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies subsurface preparation requirements for areas to receive the installation of applied and resinous flooring. This section includes removal of existing floor coverings, testing concrete for moisture and pH, remedial floor coating for concrete floor slabs having unsatisfactory moisture or pH conditions, floor leveling and repair as required.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and TEST DATA.
- B. Written approval confirming product compatibility with subfloor material manufacturer and the flooring manufacturer
- C. Product Data:
 - 1. Moisture remediation system
 - 2. Underlayment Primer
 - 3. Cementitious Self-Leveling Underlayment
 - 4. Cementitious Trowel-Applied Underlayment (Not suitable for resinous floor finishes)
- D. Test Data:
 - 1. Moisture test and pH results performed by a qualified independent testing agency or warranty holding manufacturer's technical representative.

1.4 DELIVERY AND STORAGE

- A. Deliver materials in containers with labels legible and intact and grade-seals unbroken.
- B. Store material to prevent damage or contamination.

1.5 APPLICABLE PUBLICATIONS

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

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

D638-10 (2010)	Test Method for Tensile Properties of Plastics
D4259-88 (2012)	Standard Practice for Abrading Concrete to alter the surface profile of the concrete and to remove foreign materials and weak surface laitance.
C109/C109M -12 (2012)	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens) Modified Air Cure Only
D7234-12 (2012)	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
E96/E96M - 12 (2012)	Standard Test Methods for Water Vapor Transmission of Materials
F710-11 (2011)	Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
F1869-11 (2011)	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
F2170-11 (2011)	Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes
C348-08 (2008)	Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars
C191-13 (2013)	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle

PART 2 - PRODUCTS**2.1 MOISTURE REMEDIATION COATING**

A. System Descriptions:

1. High-solids, epoxy system designed to suppress excess moisture in concrete prior to an overlayment. For use under resinous products, VCT, tile and carpet where issues caused by moisture vapor are a concern.

B. Products: Subject to compliance with applicable fire, health, environmental, and safety requirements for storage, handling, installation, and clean up.

C. System Components: Verify specific requirements as systems vary by manufacturer. Verify build up layers and installation method. Verify compatibility with substrate. Use manufacturer's standard components, compatible with each other and as follows:

1. Liquid applied coating:
 - a. Resin: epoxy.
 - b. Formulation Description: Multiple component high solids.

- c. Application: Per manufacturer's written installation requirements.
- d. Thickness: minimum 10 mils
- D. Material Vapor Permeance: Application shall achieve a permeance rating of less than 0.1 perm in accordance with ASTM E96/E96M.
- E. Maximum RH requirement: 100% testing in accordance with ASTM F2170.

Property	Test	Value
Tensile Strength	ASTM D638	4,400 psi
Volatile Organic Compound Limits (V.O.C.)	SCAMD Rule 1113	25 grams per liter
Permeance	ASTM E96	0.1 perms
Tensile Modulus	ASTM D638	1.9X10 ⁵ psi
Percent Elongation	ASTM D638	12%
Cure Rate	Per manufacture's Data	4 hours Tack free with 24hr recoat window
Bond Strength	ASTM D7234	100% bond to concrete failure

2.2 CEMENTITIOUS SELF-LEVELING UNDERLAYMENT

- A. System Descriptions:
1. High performance self-leveling underlayment resurfacer. Single component, self-leveling, cementitious material designed for easy application as an underlayment for all types of flooring materials. It is used for substrate repair and leveling.
- B. Products: Subject to compliance with applicable fire, health, environmental, and safety requirements for storage, handling, installation, and cleanup. Gypsum-based products are unacceptable.
- C. System Characteristics:
1. Wearing Surface: smooth
 2. Thickness: Per architectural drawings, ranging from feathered edge to 1", per application. Applications greater than 1" require additional 3/8" aggregate to mix or as recommended by manufacturer.
- D. Underlayment shall be calcium aluminate cement-based, containing Portland cement. Gypsum-based products are unacceptable.
- E. Compressive Strength: Minimum 4100 psi in 28 days in accordance with ASTM C109/C109M.

- F. Flexural Strength: Minimum 1000 psi in 28 days in accordance with ASTM C348
- G. Dry Time: Underlayment shall receive the application of moisture insensitive tile in 6 hours, floor coverings in 16 hours, and resinous flooring in 3-7 days.
- H. Primer: compatible and as recommended by manufacturer for use over intended substrate
- I. System Components: Manufacturer's standard components that are compatible with each other and as follows:
1. Primer:
 - a. Resin: copolymer
 - b. Formulation Description: single component ready to use.
 - c. Application Method: Squeegee and medium nap roller.
All puddles shall be removed, and material shall be allowed to dry, 1-2 hours at 70F/21C.
 - d. Number of Coats: (1) one.
 2. Grout Resurfacing Base:
 - a. Formulation Description: Single component, cementitious self-leveling high-early and high-ultimate strength grout.
 - b. Application Method: colloidal mix pump, cam rake, spike roll.
 - 1) Thickness of Coats: Per architectural scope, 1" lifts.
 - 2) Number of Coats: More than one if needed.
 - c. Aggregates: for applications greater than 1/4 inch, require additional 3/8" aggregate to mix.

Property	Test	Value
Compressive Strength	ASTM C109/C109M	2,200 psi @ 24 hrs 3,000 psi @ 7 days
Initial set time Final Set time	ASTM C191	30-45 min. 1 to 1.5 hours
Bond Strength	ASTM D7234	100% bond to concrete failure

2.3 CEMENTITIOUS TROWEL-APPLIED UNDERLAYMENT (NOT SUITABLE FOR RESINOUS FLOOR FINISHES)

- A. Underlayment shall be calcium aluminate cement-based, containing Portland cement. Gypsum-based products are unacceptable.
- B. Compressive Strength: Minimum 4000 psi in 28 days
- C. Trowel-applied underlayment shall not contain silica quartz (sand).

- D. Dry Time: Underlayment shall receive the application of floor covering in 15-20 minutes.

PART 3 - EXECUTION

3.1 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperature of work areas at not less than 16 degree C (60 degrees F), without interruption, for not less than 24 hours before testing and not less than three days after testing.
- B. Maintain higher temperatures for a longer period of time where required by manufacturer's recommendation.
- C. Do not install materials when the temperatures of the substrate or materials are not within 60-85 degrees F/ 16-30 degrees C.

3.2 SURFACE PREPARATION

- A. Existing concrete slabs with existing floor coverings:
 - 1. Conduct visual observation of existing floor covering for adhesion, water damage, alkaline deposits, and other defects.
 - 2. Remove existing floor covering and adhesives. Comply with local, state and federal regulations and the RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, as applicable to the floor covering being removed.
- B. Concrete shall meet the requirements of ASTM F710 and be sound, solid, clean, and free of all oil, grease, dirt, curing compounds, and any substance that might act as a bond-breaker before application. As required prepare slab by mechanical methods. No chemicals or solvents shall be used.
- C. General: Prepare and clean substrates according to flooring manufacturer's written instructions for substrate indicated.
- D. Prepare concrete substrates per ASTM D4259 as follows:
 - 1. Dry abrasive blasting.
 - 2. Wet abrasive blasting.
 - 3. Vacuum-assisted abrasive blasting.
 - 4. Centrifugal-shot abrasive blasting.
 - 5. Comply with manufacturer's written instructions.
- E. Repair damaged and deteriorated concrete according to flooring manufacturer's written recommendations.
- F. Verify that concrete substrates are dry.
- G. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission

rate of per flooring manufactures formal and project specific written recommendation.

- H. Perform in situ probe test, ASTM F2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity per flooring manufacture's formal and project specific written recommendation.
- I. Provide a written report showing test placement and results.
- J. Prepare joints in accordance with Section 07 92 00, JOINT SEALANTS and material manufacturer's instructions.
- K. Alkalinity: Measure surface pH in accordance with procedures provided in ASTM F710 or as outlined by qualified testing agency or flooring manufacturer's technical representative.
- L. Tolerances: Subsurface shall meet the flatness and levelness tolerance specified on drawings or recommended by the floor finish manufacturer. Tolerance shall also not to exceed 1/4" deviation in 10'. As required, install underlayment to achieve required tolerance.
- M. Other Subsurface: For all other subsurface conditions, such as wood or metal, contact the floor finish or underlayment manufacturer, as appropriate, for proper preparation practices.

3.3 MOISTURE REMEDIATION COATING:

- A. Where results of relative humidity testing (ASTM F2170) exceed the requirements of the specified flooring manufacturer, apply remedial coating as specified to correct excessive moisture condition.
- B. Prior to remedial floor coating installation mechanically prepare the concrete surface to provide a concrete surface profile in accordance with ASTM D4259.
- C. Mix and apply moisture remediation coating in accordance with manufacturer's instructions.

3.4 CEMENTITIOUS UNDERLAYMENT:

- A. Install cementitious self-leveling underlayment as required to correct surface defects, address non-moving cracks or joints, and provide a smooth surface for the installation of floor covering.
- B. Mix and apply in accordance with manufacturer's instructions.

3.5 PROTECTION

- A. Prior to the installation of the finish flooring, the surface of the underlayment should be protected from abuse by other trades by the use of plywood, tempered hardwood, or other suitable protection course

3.6 FIELD QUALITY CONTROL

- A. Where specified, field sampling of products shall be conducted by a qualified, independent testing facility.

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies installation and finishing of gypsum board.

1.2 RELATED WORK

- A. Installation of steel framing members for walls, partitions, furring, soffits, and ceilings.

1.3 TERMINOLOGY

- A. Definitions and description of terms shall be in accordance with ASTM C11, C840, and as specified.
- B. Underside of Structure Overhead: In spaces where steel trusses or bar joists are shown, the underside of structure overhead shall be the underside of the floor or roof construction supported by the trusses or bar joists.
- C. "Yoked": Gypsum board cut out for opening with no joint at the opening (along door jamb or above the door).

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Cornerbead and edge trim.
 - 2. Finishing materials.
 - 3. Laminating adhesive.
 - 4. Gypsum board, each type.
- C. Shop Drawings:
 - 1. Typical gypsum board installation, showing corner details, edge trim details and the like.
 - 2. Typical sound rated assembly, showing treatment at perimeter of partitions and penetrations at gypsum board.
 - 3. Typical shaft wall assembly.
 - 4. Typical fire rated assembly and column fireproofing, indicating details of construction same as that used in fire rating test.
- D. Samples:
 - 1. Cornerbead.
 - 2. Edge trim.
 - 3. Control joints.

E. Test Results:

- 1. Fire rating test, each fire rating required for each assembly.
- 2. Sound rating test.

F. Certificates: Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos material.

1.5 DELIVERY, IDENTIFICATION, HANDLING AND STORAGE

In accordance with the requirements of ASTM C840.

1.6 ENVIRONMENTAL CONDITIONS

In accordance with the requirements of ASTM C840.

1.7 APPLICABLE PUBLICATIONS

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

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

- C11-15Terminology Relating to Gypsum and Related Building Materials and Systems
- C475-15Joint Compound and Joint Tape for Finishing Gypsum Board
- C840-13Application and Finishing of Gypsum Board
- C919-12Sealants in Acoustical Applications
- C954-15Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Stud from 0.033 in. (0.84mm) to 0.112 in. (2.84mm) in thickness
- C1002-14Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
- C1047-14Accessories for Gypsum Wallboard and Gypsum Veneer Base
- C1177-13Glass Mat Gypsum Substrate for Use as Sheathing
- C1178/C1178M-18Specification for Coated Glass Mat Water Resistant Backing Panel
- C1658-13Glass Mat Gypsum Panels
- C1396-14Gypsum Board

C. Underwriters Laboratories Inc. (UL):

Latest EditionFire Resistance Directory

D. Inchcape Testing Services (ITS):

Latest EditionsCertification Listings

PART 2 - PRODUCTS

2.1 GYPSUM BOARD

- A. Gypsum Board: ASTM C1396, Type X, 16 mm (5/8 inch) thick unless shown otherwise.
- B. Water Resistant Gypsum Backing Board: ASTM C1178, Type X, 16 mm (5/8 inch) thick.
- C. Paper facings shall contain 100 percent post-consumer recycled paper content.

2.2 GYPSUM SHEATHING BOARD

- A. ASTM C1396, Type X, water-resistant core, 16 mm (5/8 inch) thick.
- B. ASTM C1177, Type X.

2.3 ACCESSORIES

- A. ASTM C1047, except form of 0.39 mm (0.015 inch) thick zinc coated steel sheet or rigid PVC plastic.
- B. Flanges not less than 22 mm (7/8 inch) wide with punchouts or deformations as required to provide compound bond.

2.4 FASTENERS

- A. ASTM C1002 and ASTM C840, except as otherwise specified.
- B. ASTM C954, for steel studs thicker than 0.04 mm (0.33 inch).
- C. Select screws of size and type recommended by the manufacturer of the material being fastened.
- D. For fire rated construction, type and size same as used in fire rating test.
- E. Clips: Zinc-coated (galvanized) steel; gypsum board manufacturer's standard items.

2.5 FINISHING MATERIALS AND LAMINATING ADHESIVE

ASTM C475 and ASTM C840. Free of antifreeze, vinyl adhesives, preservatives, biocides and other VOC. Adhesive shall contain a maximum VOC content of 50 g/l.

PART 3 - EXECUTION

3.1 GYPSUM BOARD HEIGHTS

- A. Extend all layers of gypsum board from floor to underside of structure overhead on following partitions and furring:
 - 1. Two sides of partitions:
 - a. Fire rated partitions.

- b. Smoke partitions.
- c. Sound rated partitions.
- d. Full height partitions shown (FHP).
- 2. One side of partitions or furring:
 - a. Inside of exterior wall furring or stud construction.
 - b. Room side of room without suspended ceilings.
 - c. Furring for pipes and duct shafts, except where fire rated shaft wall construction is shown.
- 3. Extend all layers of gypsum board construction used for fireproofing of columns from floor to underside of structure overhead, unless shown otherwise.
- B. In locations other than those specified, extend gypsum board from floor to heights as follows:
 - 1. Not less than 100 mm (4 inches) above suspended acoustical ceilings.
 - 2. At ceiling of suspended gypsum board ceilings.
 - 3. At existing ceilings.

3.2 INSTALLING GYPSUM BOARD

- A. Coordinate installation of gypsum board with other trades and related work.
- B. Install gypsum board in accordance with ASTM C840, except as otherwise specified.
- C. Moisture and Mold-Resistant Assemblies: Provide and install moisture and mold-resistant glass mat gypsum wallboard products with moisture-resistant surfaces complying with ASTM C1658 in locations which might be subject to moisture exposure during construction.
- D. Use gypsum boards in maximum practical lengths to minimize number of end joints.
- E. Bring gypsum board into contact, but do not force into place.
- F. Ceilings:
 - 1. For single-ply construction, use perpendicular application.
 - 2. For two-ply assemblies:
 - a. Use perpendicular application.
 - b. Apply face ply of gypsum board so that joints of face ply do not occur at joints of base ply with joints over framing members.
- G. Walls (Except Shaft Walls):
 - 1. When gypsum board is installed parallel to framing members, space fasteners 300 mm (12 inches) on center in field of the board, and 200 mm (8 inches) on center along edges.

2. When gypsum board is installed perpendicular to framing members, space fasteners 300 mm (12 inches) on center in field and along edges.
 3. Stagger screws on abutting edges or ends.
 4. For single-ply construction, apply gypsum board with long dimension either parallel or perpendicular to framing members as required to minimize number of joints except gypsum board shall be applied vertically over "Z" furring channels.
 5. For two-ply gypsum board assemblies, apply base ply of gypsum board to assure minimum number of joints in face layer. Apply face ply of wallboard to base ply so that joints of face ply do not occur at joints of base ply with joints over framing members.
 6. For three-ply gypsum board assemblies, apply plies in same manner as for two-ply assemblies, except that heads of fasteners need only be driven flush with surface for first and second plies. Apply third ply of wallboard in same manner as second ply of two-ply assembly, except use fasteners of sufficient length enough to have the same penetration into framing members as required for two-ply assemblies.
 7. No offset in exposed face of walls and partitions will be permitted because of single-ply and two-ply or three-ply application requirements.
 9. Control Joints ASTM C840 and as follows:
 - a. Locate at both side jambs of openings if gypsum board is not "yoked". Use one system throughout.
 - b. Not required for wall lengths less than 9000 mm (30 feet).
 - c. Extend control joints the full height of the wall or length of soffit/ceiling membrane.
- H. Electrical and Telecommunications Boxes:
1. Seal annular spaces between electrical and telecommunications receptacle boxes and gypsum board partitions.
- I. Accessories:
1. Set accessories plumb, level and true to line, neatly mitered at corners and intersections, and securely attach to supporting surfaces as specified.
 2. Install in one piece, without the limits of the longest commercially available lengths.

3. Corner Beads:
 - a. Install at all vertical and horizontal external corners and where shown.
 - b. Use screws only. Do not use crimping tool.
4. Edge Trim (casings Beads):
 - a. At both sides of expansion and control joints unless shown otherwise.
 - b. Where gypsum board terminates against dissimilar materials and at perimeter of openings, except where covered by flanges, casings or permanently built-in equipment.
 - c. Where gypsum board surfaces of non-load bearing assemblies abut load bearing members.
 - d. Where shown.

3.3 INSTALLING GYPSUM SHEATHING

- A. Install in accordance with ASTM C840, except as otherwise specified or shown.
- B. Use screws of sufficient length to secure sheathing to framing.
- C. Space screws 9 mm (3/8 inch) from ends and edges of sheathing and 200 mm (8 inches) on center. Space screws a maximum of 200 mm (8 inches) on center on intermediate framing members.
- D. Apply 600 mm by 2400 mm (2 foot by 8 foot) sheathing boards horizontally with tongue edge up.
- E. Apply 1200 mm by 2400 mm or 2700 mm (4 ft. by 8 ft. or 9 foot) gypsum sheathing boards vertically with edges over framing.

3.4 FINISHING OF GYPSUM BOARD

- A. Finish joints, edges, corners, and fastener heads in accordance with ASTM C840. Use Level 4 finish for all finished areas open to public view.
- B. Before proceeding with installation of finishing materials, assure the following:
 1. Gypsum board is fastened and held close to framing or furring.
 2. Fastening heads in gypsum board are slightly below surface in dimple formed by driving tool.
- C. Finish joints, fasteners, and all openings, including openings around penetrations, on that part of the gypsum board extending above suspended ceilings to seal surface of non-decorated smoke barrier, fire rated gypsum board construction. After the installation of hanger rods, hanger wires, supports, equipment, conduits, piping and similar

work, seal remaining openings and maintain the integrity of the smoke barrier, fire rated construction. Sanding is not required of non-decorated surfaces.

3.5 REPAIRS

- A. After taping and finishing has been completed, and before decoration, repair all damaged and defective work, including nondecorated surfaces.
- B. Patch holes or openings 13 mm (1/2 inch) or less in diameter, or equivalent size, with a setting type finishing compound or patching plaster.
- C. Repair holes or openings over 13 mm (1/2 inch) diameter, or equivalent size, with 16 mm (5/8 inch) thick gypsum board secured in such a manner as to provide solid substrate equivalent to undamaged surface.
- D. Tape and refinish scratched, abraded or damaged finish surfaces including cracks and joints in non-decorated surface to provide smoke tight construction and/or fire protection equivalent to the fire rated construction.

3.7 UNACCESSIBLE CEILINGS

At Mental Health and Behavioral Nursing Units, areas accessible to patients and not continuously observable by staff (e.g., patient bedrooms, day rooms), ceilings should be a solid material such as gypsum board. This will limit patient access. Access doors are needed to access electrical and mechanical equipment above the ceiling. These doors should be locked to prevent unauthorized access and secured to ceiling using tamper resistant fasteners.

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SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the painting and finishing as shown on the construction documents and/or specified herein, including, but not limited to, the following:
1. Prime coats which may be applied in shop under other sections.
 2. Prime painting unprimed surfaces to be painted under this Section.
 3. Painting items furnished with a prime coat of paint, including touching up of or repairing of abraded, damaged or rusted prime coats applied by others.
 4. Painting ferrous metal (except stainless steel) exposed to view.
 5. Painting galvanized ferrous metals exposed to view.
 6. Painting interior concrete block exposed to view.
 7. Painting gypsum drywall exposed to view.
 8. Painting of wood exposed to view, except items which are specified to be painted or finished under other Sections of these specifications. Back painting of all wood in contact with concrete, masonry or other moisture areas.
 9. Painting pipes, pipe coverings, conduit, ducts, insulation, hangers, supports and other mechanical and electrical items and equipment exposed to view.
 10. Painting surfaces above, behind or below grilles, gratings, diffusers, louvers lighting fixtures, and the like, which are exposed to view through these items.
 11. Painting includes shellacs, stains, varnishes, coatings specified, and striping or markers and identity markings.
 12. Incidental painting and touching up as required to produce proper finish for painted surfaces, including touching up of factory finished items.
 13. Painting of any surface not specifically mentioned to be painted herein or on construction documents, but for which painting is obviously necessary to complete the job, or work which comes within the intent of these specifications, is to be included as though specified.

1.2 RELATED WORK:

- A. Activity Hazard Analysis: Section 01 35 26, SAFETY REQUIREMENTS.
- B. Sustainable Design Requirements: Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.
- C. Masonry Repairs: Section 04 05 13, MASONRY MORTARING.
- D. Shop prime painting of steel and ferrous metals: Division 05 - METALS, Division 08 - OPENINGS; Division 14 - CONVEYING EQUIPMENT; Division 26 - ELECTRICAL; and Division 28 - ELECTRONIC SAFETY AND SECURITY sections.

1.3 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Sustainable Design Submittals as described below:
 - 1. Volatile organic compounds per volume as specified in PART 2 - PRODUCTS.
- C. Painter qualifications.
- D. Manufacturer's Literature and Data:
 - 1. Before work is started, or sample panels are prepared, submit manufacturer's literature and technical data, the current Master Painters Institute (MPI) "Approved Product List" indicating brand label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use subsequent MPI "Approved Product List", however, only one (1) list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI "Approved Product List" where applicable is acceptable.
- E. Sample Panels:
 - 1. After painters' materials have been approved and before work is started submit sample panels showing each type of finish and color specified.
 - 2. Panels to Show Color: Composition board, 100 x 250 mm (4 x 10 inch).
 - 3. Panel to Show Transparent Finishes: Wood of same species and grain pattern as wood approved for use, 100 x 250 mm (4 x 10 inch face) minimum, and where both flat and edge grain will be exposed, 250 mm (10 inches) long by sufficient size, 50 x 50 mm (2 x 2 inch) minimum or actual wood member to show complete finish.
 - 4. Attach labels to panel stating the following:

- a. Federal Specification Number or manufacturers name and product number of paints used.
- b. Product type and color.
- c. Name of project.
- 5. Strips showing not less than 50 mm (2 inch) wide strips of undercoats and 100 mm (4 inch) wide strip of finish coat.
- F. Sample of identity markers if used.
- G. Manufacturers' Certificates indicating compliance with specified requirements:
 - 1. Manufacturer's paint substituted for Federal Specification paints meets or exceeds performance of paint specified.
 - 2. High temperature aluminum paint.
 - 3. Epoxy coating.
 - 4. Intumescent clear coating or fire retardant paint.
 - 5. Plastic floor coating.

1.4 DELIVERY AND STORAGE:

- A. Deliver materials to site in manufacturer's sealed container marked to show following:
 - 1. Name of manufacturer.
 - 2. Product type.
 - 3. Batch number.
 - 4. Instructions for use.
 - 5. Safety precautions.
- B. In addition to manufacturer's label, provide a label legibly printed as following:
 - 1. Federal Specification Number, where applicable, and name of material.
 - 2. Surface upon which material is to be applied.
 - 3. Specify Coat Types: Prime; body; finish; etc.
- C. Maintain space for storage, and handling of painting materials and equipment in a ventilated, neat and orderly condition to prevent spontaneous combustion from occurring or igniting adjacent items.
- D. Store materials at site at least 24 hours before using, at a temperature between 7 and 30 degrees C (45 and 85 degrees F).

1.5 QUALITY ASSURANCE:

- A. Qualification of Painters: Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. Submit evidence that key personnel have successfully performed surface preparation and

application of coating on a minimum of three (3) similar projects within the past three (3) years.

- B. Paint Coordination: Provide finish coats which are compatible with the prime paints used. Review other Sections of these specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Upon request from other subcontractors, furnish information on the characteristics of the finish materials proposed to be used, to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Contracting Officer Representative (COR) in writing of any anticipated problems using the coating systems as specified with substrates primed by others.

1.6 REGULATORY REQUIREMENTS:

- A. Paint materials are to conform to the restrictions of the local Environmental and Toxic Control jurisdiction.
1. Volatile Organic Compounds (VOC) Emissions Requirements: Field-applied paints and coatings that are inside the waterproofing system to not exceed limits of authorities having jurisdiction.
 2. Lead-Base Paint:
 - a. Comply with Section 410 of the Lead-Based Paint Poisoning Prevention Act, as amended, and with implementing regulations promulgated by Secretary of Housing and Urban Development.
 - b. Regulations concerning prohibition against use of lead-based paint in federal and federally assisted construction, or rehabilitation of residential structures are set forth in Subpart F, Title 24, Code of Federal Regulations, Department of Housing and Urban Development.
 - c. Do not use coatings having a lead content over 0.06 percent by weight of non-volatile content.
 3. Asbestos: Provide materials that do not contain asbestos.
 4. Chromate, Cadmium, Mercury, and Silica: Provide materials that do not contain zinc-chromate, strontium-chromate, Cadmium, mercury or mercury compounds or free crystalline silica.
 5. Human Carcinogens: Provide materials that do not contain any of the ACGIH-BKLT and ACGHI-DOC confirmed or suspected human carcinogens.
 6. Use high performance acrylic paints in place of alkyd paints.

1.7 SAFETY AND HEALTH

- A. Apply paint materials using safety methods and equipment in accordance with the following:

1. Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis (AHA) as specified in Section 01 35 26, SAFETY REQUIREMENTS. The AHA is to include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.
- B. Safety Methods Used During Paint Application: Comply with the requirements of SSPC PA Guide 10.
- C. Toxic Materials: To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:
 1. The applicable manufacturer's Material Safety Data Sheets (MSDS) or local regulation.
 2. 29 CFR 1910.1000.
 3. ACHIH-BKLT and ACGHI-DOC, threshold limit values.

1.8 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. American Conference of Governmental Industrial Hygienists (ACGIH):
 - ACGIH TLV-BKLT-2012Threshold Limit Values (TLV) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs)
 - ACGIH TLV-DOC-2012Documentation of Threshold Limit Values and Biological Exposure Indices, (Seventh Edition)
- C. ASME International (ASME):
 - A13.1-07(R2013)Scheme for the Identification of Piping Systems
- D. Code of Federal Regulation (CFR):
 - 40 CFR 59Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coating
- E. Commercial Item Description (CID):
 - A-A-1272APlaster Gypsum (Spackling Compound)
- F. Federal Specifications (Fed Spec):
 - TT-P-1411APaint, Copolymer-Resin, Cementitious (For Waterproofing Concrete and Masonry Walls) (CEP)
- G. Master Painters Institute (MPI):
 - 1Aluminum Paint
 - 4Interior/ Exterior Latex Block Filler

5	.....Exterior Alkyd Wood Primer
7	.....Exterior Oil Wood Primer
8	.....Exterior Alkyd, Flat MPI Gloss Level 1
9	.....Exterior Alkyd Enamel MPI Gloss Level 6
10	.....Exterior Latex, Flat
11	.....Exterior Latex, Semi-Gloss
18	.....Organic Zinc Rich Primer
22	.....Aluminum Paint, High Heat (up to 590° - 1100F)
27	.....Exterior / Interior Alkyd Floor Enamel, Gloss
31	.....Polyurethane, Moisture Cured, Clear Gloss
36	.....Knot Sealer
43	.....Interior Satin Latex, MPI Gloss Level 4
44	.....Interior Low Sheen Latex, MPI Gloss Level 2
45	.....Interior Primer Sealer
46	.....Interior Enamel Undercoat
47	.....Interior Alkyd, Semi-Gloss, MPI Gloss Level 5
48	.....Interior Alkyd, Gloss, MPI Gloss Level 6
50	.....Interior Latex Primer Sealer
51	.....Interior Alkyd, Eggshell, MPI Gloss Level 3
52	.....Interior Latex, MPI Gloss Level 3
53	.....Interior Latex, Flat, MPI Gloss Level 1
54	.....Interior Latex, Semi-Gloss, MPI Gloss Level 5
59	.....Interior/Exterior Alkyd Porch & Floor Enamel, Low Gloss
60	.....Interior/Exterior Latex Porch & Floor Paint, Low Gloss
66	.....Interior Alkyd Fire Retardant, Clear Top-Coat (ULC Approved)
67	.....Interior Latex Fire Retardant, Top-Coat (ULC Approved)
68	.....Interior/ Exterior Latex Porch & Floor Paint, Gloss
71	.....Polyurethane, Moisture Cured, Clear, Flat
77	.....Epoxy Cold Cured, Gloss
79	.....Marine Alkyd Metal Primer
90	.....Interior Wood Stain, Semi-Transparent
91	.....Wood Filler Paste
94	.....Exterior Alkyd, Semi-Gloss

- 95Fast Drying Metal Primer
- 98High Build Epoxy Coating
- 101Epoxy Anti-Corrosive Metal Primer
- 108High Build Epoxy Coating, Low Gloss
- 114Interior Latex, Gloss
- 119Exterior Latex, High Gloss (acrylic)
- 134Galvanized Water Based Primer
- 135Non-Cementitious Galvanized Primer
- 138Interior High Performance Latex, MPI Gloss Level 2
- 139Interior High Performance Latex, MPI Gloss Level 3
- 140Interior High Performance Latex, MPI Gloss Level 4
- 141Interior High Performance Latex (SG) MPI Gloss
Level 5
- 163Exterior Water Based Semi-Gloss Light Industrial
Coating, MPI Gloss Level 5

G. Society for Protective Coatings (SSPC):

- SSPC SP 1-82(R2004)Solvent Cleaning
- SSPC SP 2-82(R2004)Hand Tool Cleaning
- SSPC SP 3-28(R2004)Power Tool Cleaning
- SSPC SP 10/NACE No.2 ...Near-White Blast Cleaning
- SSPC PA Guide 10Guide to Safety and Health Requirements

H. Maple Flooring Manufacturer's Association (MFMA):

I. U.S. National Archives and Records Administration (NARA):

- 29 CFR 1910.1000Air Contaminants

J. Underwriter's Laboratory (UL)

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

2.2 PAINT PROPERTIES:

- A. Use ready-mixed (including colors), except two component epoxies, polyurethanes, polyesters, paints having metallic powders packaged separately and paints requiring specified additives.
- B. Where no requirements are given in the referenced specifications for primers, use primers with pigment and vehicle, compatible with substrate and finish coats specified.

- C. Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer, and use only to recommended limits.
- D. VOC Content: For field applications that are inside the weatherproofing system, paints and coating to comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Non-flat Paints and Coatings: 150 g/L.
 - 3. Dry-Fog Coatings: 400 g/L.
 - 4. Primers, Sealers, and Undercoaters: 200 g/L.
 - 5. Anticorrosive and Antirust Paints applied to Ferrous Metals: 250 g/L.
 - 6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - 7. Pretreatment Wash Primers: 420 g/L.
 - 8. Shellacs, Clear: 730 g/L.
 - 9. Shellacs, Pigmented: 550 g/L.
- E. VOC test method for paints and coatings is to be in accordance with 40 CFR 59 (EPA Method 24). Part 60, Appendix A with the exempt compounds' content determined by Method 303 (Determination of Exempt Compounds) in the South Coast Air Quality Management District's (SCAQMD) "Laboratory Methods of Analysis for Enforcement Samples" manual.

2.3 PLASTIC TAPE:

- A. Pressure sensitive adhesive back.
- B. Snap on coil plastic markers.
- C. Widths as shown on construction documents.

2.4 BIOBASED CONTENT

- A. Paint products shall comply with following bio-based standards for biobased materials:

Material Type	Percent by Weight
Interior Paint	20 percent biobased material
Interior Paint- Oil Based and Solvent Alkyd	67 percent biobased material
Exterior Paint	20 percent biobased material
Wood & Concrete Stain	39 percent biobased content
Polyurethane Coatings	25 percent biobased content
Water Tank Coatings	59 percent biobased content
Wood & Concrete Sealer- Membrane Concrete Sealers	11 percent biobased content
Wood & Concrete Sealer- Penetrating Liquid	79 percent biobased content

B. The minimum-content standards are based on the weight (not the volume) of the material.

PART 3 - EXECUTION

3.1 JOB CONDITIONS:

- A. Safety: Observe required safety regulations and manufacturer's warning and instructions for storage, handling and application of painting materials.
1. Take necessary precautions to protect personnel and property from hazards due to falls, injuries, toxic fumes, fire, explosion, or other harm.
 2. Deposit soiled cleaning rags and waste materials in metal containers approved for that purpose. Dispose of such items off the site at end of each day's work.
- B. Atmospheric and Surface Conditions:
1. Do not apply coating when air or substrate conditions are:
 - a. Less than 3 degrees C (5 degrees F) above dew point.
 - b. Below 10 degrees C (50 degrees F) or over 35 degrees C (95 degrees F), unless specifically pre-approved by the COR and the product manufacturer. Under no circumstances are application conditions to exceed manufacturer recommendations.
 - c. When the relative humidity exceeds 85 percent; or to damp or wet surfaces; unless otherwise permitted by the paint manufacturer's printed instructions.
 2. Maintain interior temperatures until paint dries hard.
 3. Do no exterior painting when it is windy and dusty.
 4. Do not paint in direct sunlight or on surfaces that the sun will warm.

5. Apply only on clean, dry and frost free surfaces except as follows:
 - a. Apply water thinned acrylic and cementitious paints to damp (not wet) surfaces only when allowed by manufacturer's printed instructions.
 - b. Concrete and masonry when permitted by manufacturer's recommendations, dampen surfaces to which water thinned acrylic and cementitious paints are applied with a fine mist of water on hot dry days to prevent excessive suction and to cool surface.
6. Varnishing:
 - a. Apply in clean areas and in still air.
 - b. Before varnishing vacuum and dust area.
 - c. Immediately before varnishing wipe down surfaces with a tack rag.

3.2 INSPECTION:

- A. Examine the areas and conditions where painting and finishing are to be applied and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions are corrected to permit proper installation of the work.

3.3 GENERAL WORKMANSHIP REQUIREMENTS:

- A. Application may be by brush or roller. Spray application only upon acceptance from the COR in writing.
- B. Furnish to the COR a painting schedule indicating when the respective coats of paint for the various areas and surfaces will be completed. This schedule is to be kept current as the job progresses.
- C. Protect work at all times. Protect all adjacent work and materials by suitable covering or other method during progress of work. Upon completion of the work, remove all paint and varnish spots from floors, glass and other surfaces. Remove from the premises all rubbish and accumulated materials of whatever nature not caused by others and leave work in a clean condition.
- D. Remove and protect hardware, accessories, device plates, lighting fixtures, and factory finished work, and similar items, or provide in place protection. Upon completion of each space, carefully replace all removed items by workmen skilled in the trades involved.
- E. When indicated to be painted, remove electrical panel box covers and doors before painting walls. Paint separately and re-install after all paint is dry.

- F. Materials are to be applied under adequate illumination, evenly spread and flowed on smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.
- G. Apply materials with a coverage to hide substrate completely. When color, stain, dirt or undercoats show through final coat of paint, the surface is to be covered by additional coats until the paint film is of uniform finish, color, appearance and coverage, at no additional cost to the Government.
- H. All coats are to be dry to manufacturer's recommendations before applying succeeding coats.
- I. All suction spots or "hot spots" in plaster after the application of the first coat are to be touched up before applying the second coat.
- J. Do not apply paint behind frameless mirrors that use mastic for adhering to wall surface.

3.4 SURFACE PREPARATION:

A. General:

1. The Contractor shall be held wholly responsible for the finished appearance and satisfactory completion of painting work. Properly prepare all surfaces to receive paint, which includes cleaning, sanding, and touching-up of all prime coats applied under other Sections of the work. Broom clean all spaces before painting is started. All surfaces to be painted or finished are to be completely dry, clean and smooth.
2. See other sections of specifications for specified surface conditions and prime coat.
3. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
4. Clean surfaces before applying paint or surface treatments with materials and methods compatible with substrate and specified finish. Remove any residue remaining from cleaning agents used. Do not use solvents, acid, or steam on concrete and masonry. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall in wet, newly painted surfaces.
5. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Fiber-Cement Board: 12 percent.

- c. Masonry (Clay and CMU's): 12 percent.
 - d. Wood: 15 percent.
 - e. Gypsum Board: 12 percent.
 - f. Plaster: 12 percent.
- B. Ferrous Metals:
- 1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter in accordance with SSPC-SP 1 (Solvent Cleaning).
 - 2. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, as defined in SSPC-SP 2 (Hand Tool Cleaning) and SSPC-SP 3 (Power Tool Cleaning). Where high temperature aluminum paint is used, prepare surface in accordance with paint manufacturer's instructions.
 - 3. Fill dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with TT-F-322D (Filler, Two-Component Type, For Dents, Small Holes and Blow-Holes). Finish flush with adjacent surfaces.
 - a. Fill flat head countersunk screws used for permanent anchors.
 - b. Do not fill screws of item intended for removal such as glazing beads.
 - 4. Spot prime abraded and damaged areas in shop prime coat which expose bare metal with same type of paint used for prime coat. Feather edge of spot prime to produce smooth finish coat.
 - 5. Spot prime abraded and damaged areas which expose bare metal of factory finished items with paint as recommended by manufacturer of item.
- C. Zinc-Coated (Galvanized) Metal, Aluminum, Surfaces Specified Painted:
- 1. Clean surfaces to remove grease, oil and other deterrents to paint adhesion in accordance with SSPC-SP 1 (Solvent Cleaning).
 - 2. Spot coat abraded and damaged areas of zinc-coating which expose base metal on hot-dip zinc-coated items with MPI 18 (Organic Zinc Rich Coating). Prime or spot prime with MPI 134 (Waterborne Galvanized Primer) or MPI 135 (Non-Cementitious Galvanized Primer) depending on finish coat compatibility.
- D. Masonry, Concrete, Cement Board, Cement Plaster and Stucco:
- 1. Clean and remove dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
 - 2. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. Use of solvents, acid, or steam is not permitted.

3. Remove loose mortar in masonry work.
 4. Replace mortar and fill open joints, holes, cracks and depressions with new mortar specified in Section 04 05 13, MASONRY MORTARING Section 04 05 16, MASONRY GROUTING. Do not fill weep holes. Finish to match adjacent surfaces.
 5. Neutralize Concrete floors to be painted by washing with a solution of 1.4 Kg (3 pounds) of zinc sulfate crystals to 3.8 L (1 gallon) of water, allow to dry three (3) days and brush thoroughly free of crystals.
 6. Repair broken and spalled concrete edges with concrete patching compound to match adjacent surfaces as specified in Division 03, CONCRETE Sections. Remove projections to level of adjacent surface by grinding or similar methods.
- E. Gypsum Plaster and Gypsum Board:
1. Remove efflorescence, loose and chalking plaster or finishing materials.
 2. Remove dust, dirt, and other deterrents to paint adhesion.
 3. Fill holes, cracks, and other depressions with CID-A-A-1272A finished flush with adjacent surface, with texture to match texture of adjacent surface. Patch holes over 25 mm (1-inch) in diameter as specified in Section for plaster or gypsum board.

3.5 PAINT PREPARATION:

- A. Thoroughly mix painting materials to ensure uniformity of color, complete dispersion of pigment and uniform composition.
- B. Do not thin unless necessary for application and when finish paint is used for body and prime coats. Use materials and quantities for thinning as specified in manufacturer's printed instructions.
- C. Remove paint skins, then strain paint through commercial paint strainer to remove lumps and other particles.
- D. Mix two (2) component and two (2) part paint and those requiring additives in such a manner as to uniformly blend as specified in manufacturer's printed instructions unless specified otherwise.
- E. For tinting required to produce exact shades specified, use color pigment recommended by the paint manufacturer.

3.6 APPLICATION:

- A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.

- B. Unless otherwise specified, apply paint in three (3) coats; prime, body, and finish. When two (2) coats applied to prime coat are the same, first coat applied over primer is body coat and second coat is finish coat.
- C. Apply each coat evenly and cover substrate completely.
- D. Allow not less than 48 hours between application of succeeding coats, except as allowed by manufacturer's printed instructions, and approved by COR.
- E. Apply by brush or roller. Spray application for new or existing occupied spaces only upon approval by acceptance from COR in writing.
 - 1. Apply painting materials specifically required by manufacturer to be applied by spraying.
 - 2. In new construction and in existing occupied spaces, where paint is applied by spray, mask or enclose with polyethylene, or similar air tight material with edges and seams continuously sealed including items specified in "Building and Structural Work Field Painting"; "Work not Painted"; motors, controls, telephone, and electrical equipment, fronts of sterilizes and other recessed equipment and similar prefinished items.
- F. Do not paint in closed position operable items such as access doors and panels, window sashes, overhead doors, and similar items except overhead roll-up doors and shutters.

3.7 PRIME PAINTING:

- A. After surface preparation, prime surfaces before application of body and finish coats, except as otherwise specified.
- B. Spot prime and apply body coat to damaged and abraded painted surfaces before applying succeeding coats.
- C. Additional field applied prime coats over shop or factory applied prime coats are not required except for exterior exposed steel apply an additional prime coat.
- D. Prime rabbets for stop and face glazing of wood, and for face glazing of steel.
- E. Metals except boilers, incinerator stacks, and engine exhaust pipes:
 - 1. Steel and iron: MPI 95 (Fast Drying Metal Primer).
 - 2. Aluminum scheduled to be painted: MPI 95 (Fast Drying Metal Primer).
 - 3. Machinery not factory finished: MPI 9 (Exterior Alkyd Enamel).
 - 4. Asphalt coated metal: MPI 1 (Aluminum Paint).
 - 5. Metal over 94 degrees C (201 degrees F), Boilers, Incinerator Stacks, and Engine Exhaust Pipes: MPI 22 (High Heat Resistant Coating).

F. Gypsum Board:

1. Surfaces scheduled to have MPI 53 (Interior Latex, Flat), MPI 114 (Interior Latex, Gloss) finish: Use MPI 53 (Interior Latex, MPI Gloss Level 3), MPI 114 (Interior Latex, Gloss) respectively.

G. Concrete Masonry Units except glazed or integrally colored and decorative units:

1. MPI 4 (Block Filler) on interior surfaces.
2. Prime exterior surface as specified for exterior finishes.

H. Concrete Floors: MPI 60 (Interior/ Exterior Latex Porch & Floor Paint, Low Gloss). MPI 99 (Water-based Acrylic Curing and Sealing Compound).

3.8 EXTERIOR FINISHES:

A. Steel and Ferrous Metal, Including Tern:

1. Two (2) coats of MPI 8 (Exterior Alkyd, Flat) on exposed surfaces, except on surfaces over 94 degrees C (201 degrees F).
2. One (1) coat of MPI 22 (High Heat Resistant Coating) on surfaces over 94 degrees K (290 degrees F) and on surfaces of boiler exhaust pipes.

B. Machinery without factory finish except for primer: One (1) coat MPI 94 (Exterior Alkyd, Semi-Gloss).

C. Concrete Masonry Units, Brick and Concrete:

1. General:

- a. Mix as specified in manufacturer's printed directions.
 - b. Do not mix more paint than can be used within four (4) hours after mixing. Discard paint that has started to set.
 - c. Dampen warm surfaces above 24 degrees C (75 degrees F) with fine mist of water before application of paint. Do not leave free water on surface.
 - d. Cure paint with a fine mist of water as specified in manufacturer's printed instructions.
2. Use two (2) coats of TT-P-1411 (Paint, Co-polymer-Resin, Cementitious), unless specified otherwise.

3.9 INTERIOR FINISHES:

A. Apply following finish coats over prime coats in spaces or on surfaces specified.

B. Metal Work:

1. Apply to exposed surfaces.
2. Omit body and finish coats on surfaces concealed after installation except electrical conduit containing conductors over 600 volts.

3. Ferrous Metal, Galvanized Metal, and Other Metals Scheduled:
 - a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) unless specified otherwise.
 - b. Two (2) coats of MPI 51 (Interior Alkyd, Eggshell).
 - c. One (1) coat of MPI 46 (Interior Enamel Undercoat) plus one coat of MPI 47 (Interior Alkyd, Semi-Gloss) on exposed interior surfaces of alkyd-amine enamel prime finished windows.
 - d. One (1) coat of MPI 101 primer over two (2) coats of waterborne light industrial coating MPI 163 on exposed surfaces. Steel is to be blast cleaned to SSPC 10/NACE No. 2.
 - e. Machinery: One (1) coat MPI 9 (Exterior Alkyd Enamel).
 - f. Asphalt Coated Metal: One (1) coat MPI 1 (Aluminum Paint).
 - g. Ferrous Metal over 94 degrees K (290 degrees F): Boilers, Incinerator Stacks, and Engine Exhaust Pipes: One (1) coat MPI 22 (High Heat Resistant Coating).

C. Gypsum Board:

1. One (1) coat of MPI 45 (Interior Primer Sealer) plus one (1) coat of MPI 139 (Interior High Performance Latex, MPI Gloss level 3).
2. Two (2) coats of MPI 138 (Interior High Performance Latex, MPI Gloss Level 2).
3. One (1) coat of MPI 45 (Interior Primer Sealer) plus one (1) coat of MPI 54 (Interior Latex, Semi-Gloss, MPI Gloss Level 5) or MPI 114 (Interior Latex, Gloss).
4. One (1) coat of MPI 45 (Interior Primer Sealer) plus one (1) coat of MPI 48 (Interior Alkyd Gloss).

D. Masonry and Concrete Walls:

1. Over MPI 4 (Interior/Exterior Latex Block Filler) on CMU surfaces.
2. Two (2) coats of MPI 53 (Interior Latex, Flat, MPI Gloss Level 1).

E. Concrete Floors: One (1) coat of MPI 68 (Interior/ Exterior Latex Porch & Floor Paint, Gloss).

F. Miscellaneous:

1. MPI 1 (Aluminum Paint): Two (2) coats of aluminum paint.

3.10 REFINISHING EXISTING PAINTED SURFACES:

- A. Clean, patch and repair existing surfaces as specified under "Surface Preparation". No "telegraphing" of lines, ridges, flakes, etc., through new surfacing is permitted. Where this occurs, sand smooth and re-finish until surface meets with COR's approval.

- B. Remove and reinstall items as specified under "General Workmanship Requirements".
- C. Remove existing finishes or apply separation coats to prevent non compatible coatings from having contact.
- D. Patched or Replaced Areas in Surfaces and Components: Apply spot prime and body coats as specified for new work to repaired areas or replaced components.
- E. Except where scheduled for complete painting apply finish coat over plane surface to nearest break in plane, such as corner, reveal, or frame.
- F. Refinish areas as specified for new work to match adjoining work unless specified or scheduled otherwise.
- G. Sand or dull glossy surfaces prior to painting.
- H. Sand existing coatings to a feather edge so that transition between new and existing finish will not show in finished work.

3.11 PAINT COLOR:

- A. For additional requirements regarding color see Articles, "REFINISHING EXISTING PAINTED SURFACE" and "MECHANICAL AND ELECTRICAL FIELD PAINTING SCHEDULE".
- B. Coat Colors:
 - 1. Color of priming coat: Lighter than body coat.
 - 2. Color of body coat: Lighter than finish coat.
 - 3. Color prime and body coats to not show through the finish coat and to mask surface imperfections or contrasts.
- C. Painting, Caulking, Closures, and Fillers Adjacent to Casework:
 - 1. Paint to match color of casework where casework has a paint finish.
 - 2. Paint to match color of wall where casework is stainless steel, plastic laminate, or varnished wood.

3.12 MECHANICAL AND ELECTRICAL WORK FIELD PAINTING SCHEDULE:

- A. Field painting of mechanical and electrical consists of cleaning, touching-up abraded shop prime coats, and applying prime, body and finish coats to materials and equipment if not factory finished in space scheduled to be finished.
- B. Paint various systems specified in Division 02 - EXISTING CONDITIONS, Division 23 - HEATING, VENTILATION AND AIR-CONDITIONING, and Division 26 - ELECTRICAL.
- C. Paint after tests have been completed.
- D. Omit prime coat from factory prime-coated items.

- E. Finish painting of mechanical and electrical equipment is not required when located in interstitial spaces, above suspended ceilings, in concealed areas such as pipe and electric closets, pipe basements, pipe tunnels, trenches, attics, roof spaces, shafts and furred spaces except on electrical conduit containing feeders 600 volts or more.
- F. Omit field painting of items specified in "BUILDING AND STRUCTURAL WORK FIELD PAINTING"; "Building and Structural Work not Painted".
- G. Color:
1. Paint items having no color specified to match surrounding surfaces.
 2. Paint colors as specified for following:
 - a. White: Exterior unfinished surfaces of enameled plumbing fixtures. Insulation coverings on breeching and uptake inside boiler house, drums and drum-heads, oil heaters, condensate tanks and condensate piping.
 - b. Gray: Heating, ventilating, air conditioning and refrigeration equipment (except as required to match surrounding surfaces), and water and sewage treatment equipment and sewage ejection equipment.
 - c. Aluminum Color: Ferrous metal on outside of boilers and in connection with boiler settings including supporting doors and door frames and fuel oil burning equipment, and steam generation system (bare piping, fittings, hangers, supports, valves, traps and miscellaneous iron work in contact with pipe).
 - d. Federal Safety Red: Exposed fire protection piping hydrants, post indicators, electrical conducts containing fire alarm control wiring, and fire alarm equipment.
 - e. Federal Safety Orange: Entire lengths of electrical conduits containing feeders 600 volts or more.
 - f. Color to match brickwork sheet metal covering on breeching outside of exterior wall of boiler house.
- H. Apply paint systems on properly prepared and primed surface as follows:
1. Exterior Locations:
 - a. Apply two (2) coats of MPI 94 (Exterior Alkyd, Semi-gloss) to the following ferrous metal items:

Vent and exhaust pipes with temperatures under 94 degrees C (201 degrees F), roof drains, fire hydrants, post indicators, yard hydrants, exposed piping and similar items.

- b. Apply two (2) coats of MPI 11 (Exterior Latex, Semi-Gloss) to galvanized and zinc-copper alloy metal.
 - c. Apply one (1) coat of MPI 22 (High Heat Resistant Coating), 650 degrees C (1200 degrees F) to incinerator stacks, boiler stacks, and engine generator exhaust.
2. Interior Locations:
- a. Apply two (2) coats of MPI 47 (Interior Alkyd, Semi-Gloss) to following items:
 - 1) Metal under 94 degrees C (201 degrees F) of items such as bare piping, fittings, hangers and supports.
 - 2) Equipment and systems such as hinged covers and frames for control cabinets and boxes, cast-iron radiators, electric conduits and panel boards.
 - 3) Heating, ventilating, air conditioning, plumbing equipment, and machinery having shop prime coat and not factory finished.
 - b. Apply one (1) coat of MPI 50 (Interior Latex Primer Sealer) and one (1) coat of MPI 53 (Interior Latex, Flat, MPI Gloss Level 1) on finish of insulation on boiler breeching and uptakes inside boiler house, drums, drumheads, oil heaters, feed water heaters, tanks and piping.
 - c. Apply two (2) coats of MPI 22 (High Heat Resistant Coating) to ferrous metal surface over 94 degrees K (290 degrees F) of following items:
 - 1) Exterior of boilers and ferrous metal in connection with boiler settings including supporting members, doors and door frames and fuel oil burning equipment.
 - 2) Steam line flanges, bare pipe, fittings, valves, hangers and supports over 94 degrees K (290 degrees F).
 - 3) Engine generator exhaust piping and muffler.
 - d. Paint electrical conduits containing cables rated 600 volts or more using two (2) coats of MPI 9 (Exterior Alkyd Enamel) in the Federal Safety Orange color in exposed and concealed spaces full length of conduit.
3. Other exposed locations:
- a. Metal surfaces, except aluminum, of cooling towers exposed to view, including connected pipes, rails, and ladders: Two (2) coats of MPI 1 (Aluminum Paint).

- b. Cloth jackets of insulation of ducts and pipes in connection with plumbing, air conditioning, ventilating refrigeration and heating systems: One (1) coat of MPI 50 (Interior Latex Primer Sealer) and one (1) coat of MPI 119 (Exterior Latex, High Gloss (acrylic)).

3.13 BUILDING AND STRUCTURAL WORK FIELD PAINTING:

- A. Painting and finishing of interior and exterior work except as specified here-in-after.
 - 1. Painting and finishing of new and existing work including colors and gloss of finish selected is specified in Finish Schedule.
 - 2. Painting of disturbed, damaged, and repaired or patched surfaces when entire space is not scheduled for complete repainting or refinishing.
 - 3. Painting of ferrous metal and galvanized metal.
 - 4. Identity painting and safety painting.
- B. Building and Structural Work not Painted:
 - 1. Prefinished items:
 - a. Casework, doors, elevator entrances and cabs, metal panels, wall covering, and similar items specified factory finished under other sections.
 - b. Factory finished equipment and pre-engineered metal building components such as metal roof and wall panels.
 - 2. Finished surfaces:
 - a. Hardware except ferrous metal.
 - b. Anodized aluminum, stainless steel, chromium plating, copper, and brass, except as otherwise specified.
 - c. Signs, fixtures, and other similar items integrally finished.
 - 3. Concealed surfaces:
 - a. Inside dumbwaiter, elevator and duct shafts, interstitial spaces, pipe basements, crawl spaces, pipe tunnels, above ceilings, attics, except as otherwise specified.
 - b. Inside walls or other spaces behind access doors or panels.
 - c. Surfaces concealed behind permanently installed casework and equipment.
 - 4. Moving and operating parts:
 - a. Shafts, chains, gears, mechanical and electrical operators, linkages, and sprinkler heads, and sensing devices.
 - b. Tracks for overhead or coiling doors, shutters, and grilles.
 - 5. Labels:

- a. Code required label, such as Underwriters Laboratories Inc., Intertek Testing Service or Factory Mutual Research Corporation.
 - b. Identification plates, instruction plates, performance rating, and nomenclature.
6. Galvanized metal:
- a. Exterior chain link fence and gates, corrugated metal areaways, and gratings.
 - b. Gas Storage Racks.
 - c. Except where specifically specified to be painted.
7. Metal safety treads and nosings.
8. Gaskets.
9. Concrete curbs, gutters, pavements, retaining walls, exterior exposed foundations walls and interior walls in pipe basements.
10. Face brick.
11. Structural steel encased in concrete, masonry, or other enclosure.
12. Structural steel to receive sprayed-on fire proofing.
13. Ceilings, walls, columns in interstitial spaces.
14. Ceilings, walls, and columns in pipe basements.
15. Wood Shingles.

3.14 IDENTITY PAINTING SCHEDULE:

- A. Identify designated service in new buildings or projects with extensive remodeling in accordance with ASME A13.1, unless specified otherwise, on exposed piping, piping above removable ceilings, piping in accessible pipe spaces, interstitial spaces, and piping behind access panels. For existing spaces where work is minor match existing.
1. Legend may be identified using snap-on coil plastic markers or by paint stencil applications.
 2. Apply legends adjacent to changes in direction, on branches, where pipes pass through walls or floors, adjacent to operating accessories such as valves, regulators, strainers and cleanouts a minimum of 12.2 M (40 feet) apart on straight runs of piping. Identification next to plumbing fixtures is not required.
 3. Locate Legends clearly visible from operating position.
 4. Use arrow to indicate direction of flow using black stencil paint.
 5. Identify pipe contents with sufficient additional details such as temperature, pressure, and contents to identify possible hazard. Insert

working pressure shown on construction documents where asterisk appears for High, Medium, and Low Pressure designations as follows:

- a. High Pressure - 414 kPa (60 psig) and above.
- b. Medium Pressure - 104 to 413 kPa (15 to 59 psig).
- c. Low Pressure - 103 kPa (14 psig) and below.
- d. Add Fuel oil grade numbers.

6. Legend name in full or in abbreviated form as follows:

PIPING	COLOR OF EXPOSED PIPING	COLOR OF BACKGROUND	COLOR OF LETTERS	LEGEND ABBREVIATIONS
Blow-off		Green	White	Blow-off
Boiler Feedwater		Green	White	Blr Feed
A/C Condenser Water Supply		Green	White	A/C Cond Wtr Sup
A/C Condenser Water Return		Green	White	A/C Cond Wtr Ret
Chilled Water Supply		Green	White	Ch. Wtr Sup
Chilled Water Return		Green	White	Ch. Wtr Ret
Shop Compressed Air		Blue	White	Shop Air
Air-Instrument Controls		Green	White	Air-Inst Cont
Drain Line		Green	White	Drain
Emergency Shower		Green	White	Emg Shower
High Pressure Steam		Green	White	H.P. _____*
High Pressure Condensate Return		Green	White	H.P. Ret _____*
Medium Pressure Steam		Green	White	M. P. Stm _____*
Medium Pressure Condensate Return		Green	White	M.P. Ret _____*
Low Pressure Steam		Green	White	L.P. Stm _____*
Low Pressure Condensate Return		Green	White	L.P. Ret _____*
High Temperature Water Supply		Green	White	H. Temp Wtr Sup
High Temperature Water Return		Green	White	H. Temp Wtr Ret
Hot Water Heating Supply		Green	White	H. W. Htg Sup
Hot Water Heating Return		Green	White	H. W. Htg Ret
Gravity Condensate Return		Green	White	Gravity Cond Ret
Pumped Condensate Return		Green	White	Pumped Cond Ret
Vacuum Condensate Return		Green	White	Vac Cond Ret
Fuel Oil - Grade _____ (Diesel Fuel included under Fuel Oil)		Brown	White	Fuel Oil-Grade _____
Boiler Water Sampling		Green	White	Sample

Chemical Feed		Green	White	Chem Feed
Continuous Blow-Down		Green	White	Cont. B D
Pumped Condensate		Green	White	Pump Cond
Pump Recirculating		Green	White	Pump-Recirc.
Vent Line		Green	White	Vent
Alkali		Orange	Black	Alk
Bleach		Orange	Black	Bleach
Detergent		Yellow	Black	Det
Liquid Supply		Yellow	Black	Liq Sup
Reuse Water		Yellow	Black	Reuse Wtr
Cold Water (Domestic)	White	Green	White	C.W. Dom
Hot Water (Domestic)				
Supply	White	Yellow	Black	H.W. Dom
Return	White	Yellow	Black	H.W. Dom Ret
Tempered Water	White	Yellow	Black	Temp. Wtr
Ice Water				
Supply	White	Green	White	Ice Wtr
Return	White	Green	White	Ice Wtr Ret
Reagent Grade Water		Green	White	RG
Reverse Osmosis		Green	White	RO
Sanitary Waste		Green	White	San Waste
Sanitary Vent		Green	White	San Vent
Storm Drainage		Green	White	St Drain
Pump Drainage		Green	White	Pump Disch
Chemical Resistant Pipe				
Waste		Orange	Black	Acid Waste
Vent		Orange	Black	Acid Vent
Atmospheric Vent		Green	White	ATV
Silver Recovery		Green	White	Silver Rec
Oral Evacuation		Green	White	Oral Evac
Fuel Gas		Yellow	Black	Gas
Fire Protection Water				
Sprinkler	Red	Red	White	Auto Spr
Standpipe	Red	Red	White	Stand
Sprinkler	Red	Red	White	Drain

B. Fire and Smoke Partitions:

1. Identify partitions above ceilings on both sides of partitions except within shafts in letters not less than 64 mm (2 1/2 inches) high.
2. Stenciled message: "SMOKE BARRIER" or, "FIRE BARRIER" as applicable.

3. Locate not more than 6096 mm (20 feet) on center on corridor sides of partitions, and with a least one (1) message per room on room side of partition.
 4. Use semi-gloss paint of color that contrasts with color of substrate.
- C. Identify columns in pipe basements and interstitial space:
1. Apply stenciled number and letters to correspond with grid numbering and lettering indicated on construction documents.
 2. Paint numbers and letters 101 mm (4 inches) high, locate 45 mm (1.8 inches) below overhead structural slab.
 3. Apply on four (4) sides of interior columns and on inside face only of exterior wall columns.
 4. Color:
 - a. Use black on concrete columns.
 - b. Use white or contrasting color on steel columns.

3.15 PROTECTION CLEAN UP, AND TOUCH-UP:

- A. Protect work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.
- B. Upon completion, clean paint from hardware, glass and other surfaces and items not required to be painted of paint drops or smears.
- C. Before final inspection, touch-up or refinished in a manner to produce solid even color and finish texture, free from defects in work which was damaged or discolored.

- - - E N D - - -

SECTION 23 05 10
COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23 related to boiler plant and steam generation.

B. Definitions:

1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
2. Exterior: Piping, ductwork, and equipment exposed to weather be it temperature, humidity, precipitation, wind, or solar radiation.

C. Abbreviations/Acronyms:

1. ac: Alternating Current
2. ACR: Air Conditioning and Refrigeration
3. AI: Analog Input
4. AISI: American Iron and Steel Institute
5. AO: Analog Output
6. ASJ: All Service Jacket
7. AWG: American Wire Gauge
8. BACnet: Building Automation and Control Networking Protocol
9. BA_g: Silver-Copper-Zinc Brazing Alloy
10. BAS: Building Automation System
11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
12. bhp: Brake Horsepower
13. Btu: British Thermal Unit
14. Btu/h: British Thermal Unit Per Hour
15. CDA: Copper Development Association
16. C: Celsius
17. CD: Compact Disk
18. CFM: Cubic Foot Per Minute
19. CH: Chilled Water Supply
20. CHR: Chilled Water Return
21. CLR: Color
22. CO: Carbon Monoxide
23. COR: Contracting Officer's Representative
24. CPD: Condensate Pump Discharge

25.CPM: Cycles Per Minute
26.CPVC: Chlorinated Polyvinyl Chloride
27.CRS: Corrosion Resistant Steel
28.CTPD: Condensate Transfer Pump Discharge
29.CTPS: Condensate Transfer Pump Suction
30.CW: Cold Water
31.CWP: Cold Working Pressure
32.CxA: Commissioning Agent
33.dB: Decibels
34.dB(A): Decibels (A weighted)
35.DDC: Direct Digital Control
36.DI: Digital Input
37.DO: Digital Output
38.DVD: Digital Video Disc
39.DN: Diameter Nominal
40.DWV: Drainage, Waste and Vent
41.EPDM: Ethylene Propylene Diene Monomer
42.EPT: Ethylene Propylene Terpolymer
43.ETO: Ethylene Oxide
44.F: Fahrenheit
45.FAR: Federal Acquisition Regulations
46.FD: Floor Drain
47.FED: Federal
48.FG: Fiberglass
49.FGR: Flue Gas Recirculation
50.FOS: Fuel Oil Supply
51.FOR: Fuel Oil Return
52.FSK: Foil-Scrim-Kraft facing
53.FWPD: Feedwater Pump Discharge
54.FWPS: Feedwater Pump Suction
55.GC: Chilled Glycol Water Supply
56.GCR: Chilled Glycol Water Return
57.GH: Hot Glycol Water Heating Supply
58.GHR: Hot Glycol Water Heating Return
59.gpm: Gallons Per Minute
60.HDPE: High Density Polyethylene

61.Hg: Mercury
62.HOA: Hands-Off-Automatic
63.hp: Horsepower
64.HPS: High Pressure Steam (equal to/greater than 414 kPa (60 psig))
65.HPR: High Pressure Steam Condensate Return
66.HW: Hot Water
67.HWH: Hot Water Heating Supply
68.HWHR: Hot Water Heating Return
69.Hz: Hertz
70.ID: Inside Diameter
71.IPS: Iron Pipe Size
72.kg: Kilogram
73.klb: 1000 lb
74.kPa: Kilopascal
75.lb: Pound
76.lb/hr: Pounds Per Hour
77.L/s: Liters Per Second
78.L/min: Liters Per Minute
79.LPS: Low Pressure Steam (equal to/less than 103 kPa (15 psig))
80.LPR: Low Pressure Steam Condensate Gravity Return
81.MAWP: Maximum Allowable Working Pressure
82.MAX: Maximum
83.MBtu/h: 1000 Btu/h
84.MBtu: 1000 Btu
85.MED: Medical
86.m: Meter
87.MFG: Manufacturer
88.mg: Milligram
89.mg/L: Milligrams Per Liter
90.MIN: Minimum
91.MJ: Megajoules
92.ml: Milliliter
93.mm: Millimeter
94.MPS: Medium Pressure Steam (110-414 kPa [16-60 psig])
95.MPR: Medium Pressure Steam Condensate Return
96.MW: Megawatt

97.NC: Normally Closed
98.NF: Oil Free Dry (Nitrogen)
99.Nm: Newton Meter
100.NO: Normally Open
101.NOx: Nitrous Oxide
102.NPT: National Pipe Thread
103.NPS: Nominal Pipe Size
104.OD: Outside Diameter
105.OSD: Open Sight Drain
106.OS&Y: Outside Stem and Yoke
107.PC: Pumped Condensate
108.PID: Proportional-Integral-Differential
109.PLC: Programmable Logic Controllers
110.PP: Polypropylene
111.PPE: Personal Protection Equipment
112.ppb: Parts Per Billion
113.ppm: Parts Per Million
114.PRV: Pressure Reducing Valve
115.PSIA: Pounds Per Square Inch Absolute
116.psig: Pounds Per Square Inch Gauge
117.PTFE: Polytetrafluoroethylene
118.PVC: Polyvinyl Chloride
119.PVDC: Polyvinylidene Chloride Vapor Retarder Jacketing, White
120.PVDF: Polyvinylidene Fluoride
121.rad: Radians
122.RH: Relative Humidity
123.RO: Reverse Osmosis
124.rms: Root Mean Square
125.RPM: Revolutions Per Minute
126.RS: Refrigerant Suction
127.RTD: Resistance Temperature Detectors
128.RTRF: Reinforced Thermosetting Resin Fittings
129.RTRP: Reinforced Thermosetting Resin Pipe
130.SCFM: Standard Cubic Feet Per Minute
131.SPEC: Specification
132.SPS: Sterile Processing Services

133.STD: Standard
134.SDR: Standard Dimension Ratio
135.SUS: Saybolt Universal Second
136.SW: Soft water
137.SWP: Steam Working Pressure
138.TAB: Testing, Adjusting, and Balancing
139.TDH: Total Dynamic Head
140.TEFC: Totally Enclosed Fan-Cooled
141.TFE: Tetrafluoroethylene
142.THERM: 100,000 Btu
143.THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
144.THWN: Thermoplastic Heat & Water-Resistant Nylon Coated Wire
145.T/P: Temperature and Pressure
146.USDA: U.S. Department of Agriculture
147.V: Volt
148.VAC: Vacuum
149.VA: Veterans Administration
150.VAC: Voltage in Alternating Current
151.VA CFM: VA Construction & Facilities Management
152.VA CFM CSS: Consulting Support Service
153.VAMC: Veterans Administration Medical Center
154.VHA OCAMES: Veterans Health Administration - Office of Capital
Asset Management Engineering and Support
155.VR: Vacuum condensate return
156.WCB: Wrought Carbon Steel, Grade B
157.WG: Water Gauge or Water Column
158.WOG: Water, Oil, Gas

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- G. Section 05 50 00, METAL FABRICATIONS.
- H. Section 07 60 00, FLASHING AND SHEET METAL.

- I. Section 07 84 00, FIRESTOPPING.
- J. Section 07 92 00, JOINT SEALANTS.
- K. Section 09 91 00, PAINTING.
- L. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- M. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- N. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- O. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- P. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- Q. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
- R. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- S. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- T. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- U. Section 23 52 39, FIRE-TUBE BOILERS.
- V. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- W. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- X. Section 26 29 11, MOTOR CONTROLLERS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. Air Movement and Control Association (AMCA):
 - 410-1996Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans
- C. American Society of Mechanical Engineers (ASME):
 - B31.1-2014Power Piping
 - B31.9-2014Building Services Piping
 - ASME Boiler and Pressure Vessel Code:
 - BPVC Sec I-2019Rules for Construction of Power Boilers
 - BPVC Sec IX-2019Welding, Brazing, and Fusing Qualifications
- D. American Society for Testing and Materials (ASTM):
 - A36/A36M-2017Standard Specification for Carbon Structural Steel
 - A575-2018Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

- E. Association for Rubber Products Manufacturers (ARPM):
 - IP-20-2015Specifications for Drives Using Classical
V-Belts and Sheaves
 - IP-21-2016Specifications for Drives Using Double-V
(Hexagonal) Belts
- F. International Code Council, (ICC):
 - IMC-2018International Mechanical Code
- G. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc.:
 - SP-58-2018Pipe Hangers and Supports-Materials, Design,
Manufacture, Selection, Application, and
Installation
 - SP-127-2014aBracing for Piping Systems: Seismic-Wind-
Dynamic Design, Selection, and Application
- H. Military Specifications (MIL):
 - MIL-P-21035B-2003Paint High Zinc Dust Content, Galvanizing
Repair (Metric)
- I. National Fire Protection Association (NFPA):
 - 31-2019Standard for Installation of Oil-Burning
Equipment
 - 54-2018National Fuel Gas Code
 - 70-2017National Electrical Code (NEC)
 - 85-2019Boiler and Combustion Systems Hazards Code
 - 101-2018Life Safety Code
- J. Department of Veterans Affairs (VA):
 -VHA Boiler Plant Safety Devices Testing Manual,
Fifth Edition
 - PG-18-10-2016Steam, Heating Hot Water, and Outside
Distribution Systems Design Manual
 - PG-18-10-2011Asbestos Abatement Design Manual
 - PG-18-10-2014Sustainable Design Manual
 - PG-18-10-2016/Physical Security and Resiliency Design Manual

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION", with applicable paragraph identification.
- C. All submittals in these sections are for equipment and materials that are interdependent parts of the entire systems; therefore, they shall all be submitted at the same time and complete including coordination/shop drawings, installation instructions, structural support, and structural piping calculations so that they may be reviewed as a system. The submittals for each Section shall be covered by one individual transmittal signed by the prime Contractor and containing a statement that the Contractor has fully reviewed all documents. Deviations from the contract documents, if any, shall be listed on the transmittal.
- D. If the project is phased submit complete phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.
- E. Test Plans: Submit safety test plan for temporary steam plant with temporary steam plant submittals. Submit all other test plans for plant and equipment 45 days prior to start of testing to allow for test modifications prior to start.
- F. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements, and all equipment that requires regular maintenance, calibration, etc, are accessible from the floor or permanent work platform. It is the Contractor's responsibility to ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specifications unless the Contractor has requested a variance in writing and approved by COR prior to the submittal. If at any time during the project it is found that any item does not meet the VA specifications and there was no variance approval the Contractor shall correct at no additional cost or time to the Government even if a submittal was approved.
- G. If equipment is submitted which differs in arrangement from that shown, provide documentation proving equivalent performance, design standards

and drawings that show the rearrangement of all associated systems. Additionally, any impacts on ancillary equipment or services such as foundations, piping, and electrical shall be the Contractor's responsibility to design, supply, and install at no additional cost or time to the Government. VA approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

- H. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed contract documents and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- I. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together. Coordinate and properly integrate materials and equipment to provide a completely compatible and efficient installation.
- J. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made.
- K. Coordination/Shop Drawings:
 - 1. Submit complete consolidated and coordinated shop drawings for all new systems, and for existing systems that are in the same areas.
 - 2. The coordination/shop drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed coordination/shop drawings of all piping and duct systems. The drawings should include all

- lockout/tagout points for all energy/hazard sources for each piece of equipment. Coordinate lockout/tagout procedures and practices with local VA requirements.
3. Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.
 4. In addition, for HVAC systems, provide details of the following:
 - a. Mechanical equipment rooms.
 - b. Hangers, inserts, supports, and bracing.
 - c. Pipe sleeves.
 - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- L. Manufacturer's Literature and Data: Include full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity. Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the COR.
 2. Submit electric motor data and variable speed drive data with the driven equipment.
 3. Equipment and materials identification.
 4. Fire-stopping materials.
 5. Hangers, inserts, supports and bracing. Provide complete stress analysis for variable spring and constant support hangers. For boiler plants, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, for additional requirements.
 6. Wall, floor, and ceiling plates.
- M. Rigging Plan: Provide documentation of the capacity and weight of the rigging and equipment intended to be used. The rigging plan shall include the path of travel of the load, the staging area and intended access, and qualifications of the operator and signal person.
- N. Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, paragraph, INSTRUCTIONS, for systems and equipment.

2. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - a. Include complete list indicating all components of the systems.
 - b. Include complete diagrams of the internal wiring for each item of equipment.
 - c. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.
 3. 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.
- O. Boiler Plant Maintenance Data and Operating Instructions:
1. Provide 4 bound copies and 2 electronic versions on DVD. 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, horsepower, pump impeller size, other data.
 4. Manufacturer's installation, maintenance, repair, and operation instructions for each device. Include assembly drawings and parts lists. Include operating precautions and reasons for precautions.
 5. Lubrication instructions including type and quantity of lubricant.
 6. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications.
 7. Description of boiler firing and operating sequence including description of relay and interlock positions at each part of the sequence.
 8. Set points of all interlock devices.
 9. Trouble-shooting guide for control systems.
 10. Operation of the combustion control system.
 11. Emergency procedures.
 12. Control system programming information for parameters, such as set points, that do not require services of an experienced technician.

13. Step-by-Step written instructions that are specific for the system installed on testing all safety devices. The instructions should be in the same format and in compliance and equivalent to the VHA Boiler Plant Safety Devices Testing Manual for each test. All safety devices listed in the manual shall be tested and documentation provided certifying completion.

- P. Provide copies of approved HVAC equipment submittals to the TAB and Commissioning Subcontractor.
- Q. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- R. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 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. All VA safety device requirements shall be complied with regardless of the size, type, or operating pressure of boiler to include condensing boilers, hot water boilers for heating systems, as defined in the VHA Boiler Plant Safety Devices Testing Manual. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC or steam boiler plant construction, as applicable.
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
- D. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of

- the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
2. Refer to all other sections for quality assurance requirements for systems and equipment specified therein.
 3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 4. The products and execution of work specified in Division 33 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.
 5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).
 6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
 7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
 8. Use of asbestos products or equipment or materials containing asbestos is prohibited.

- E. Boiler Plant Equipment Service Providers: Service providers shall be authorized and trained by the manufacturers of the equipment supplied. These providers shall be capable of responding onsite and provide acceptable service to restore boiler plant operations within 4 hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shutdown of equipment; or within 24 hours in a non-emergency. Submit names, mail and e-mail addresses and phone numbers of service personnel and companies providing service under these conditions for (as applicable to the project): burners, burner control systems, boiler control systems, pumps, critical instrumentation, computer workstation and programming.
- F. Mechanical Systems Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVC Section IX. Provide proof of current certification.
 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
 3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
 4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the associated code.
- G. Boiler Plant and Outside Steam Distribution Welding: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS and Section 33 63 00, STEAM ENERGY DISTRIBUTION.
- H. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR with submittals. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material and removal by the Contractor and no additional cost or time to the Government.

I. 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 documents to the COR for resolution. Provide written hard copies and computer files on CD or DVD of manufacturer's installation instructions to the COR with submittals prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received and approved by VA. 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 documents to the COR for resolution. Failure of the Contractor to resolve or point out any issues will result in the Contractor correcting at no additional cost or time to the Government.
3. Complete coordination/shop drawings shall be required in accordance with paragraph, SUBMITTALS. Construction work shall not start on any system until the coordination/shop drawings have been approved by VA.
4. Workmanship/craftsmanship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Government.

J. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.

K. Guaranty: Warranty of Construction, FAR Clause 52.246-21.

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 or theft.
2. Large equipment such as boilers, tanks, economizers, heat exchangers, and fans if shipped on open trailer trucks shall be covered with shrink on plastics or water proof tarpaulins that provide protection from exposure to rain, road salts and other transit hazards. Protection shall be kept in place until equipment is moved into a building or installed as designed.
3. Repair damaged equipment in first class, new operating condition, and appearance; or, replace same as determined and directed by the COR. Such repair or replacement shall be at no additional cost or time to the Government.
4. 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.
5. 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.
6. Protect plastic piping and tanks from ultraviolet light (sunlight).

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading, and welding of piping.
2. Piping systems shall be flushed, blown, or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.
- C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
 - 1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures

followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.8 JOB CONDITIONS - WORK IN EXISTING BOILER PLANT

- A. Plant Operation: Government employees will be continuously operating and managing all plant facilities, including temporary facilities, that serve the steam, and condensate requirements of the VAMC.
- B. Maintenance of Steam Supply and Condensate Return Service: Schedule all work to permit continuous steam and condensate service at pressures and flow rates as required by the VAMC. At all times, there shall be one spare boiler available and one spare pump for each service available, in addition to those required for serving the load demand. The spare boiler and pumps must be capable of handling the loads that may be imposed if the operating boiler or pump fails.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the COR during periods when the steam demands are not critical to the operation of the VAMC. These non-critical periods are limited to between 8 pm and 5 am during the non-heating season. Provide at least 10 working days advance notice to the COR. The request shall include a detailed plan on the proposed shutdown and the intended work to be done along with manpower levels. All equipment and materials must be onsite and verified with plan 7 days prior to the shutdown or it will need to be rescheduled.
- D. Phasing of Work: Comply with all requirements shown on contract documents. Contractor shall submit a complete detailed phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.

- E. Plant Working Environment: Maintain the architectural and structural integrity of the plant building and the working environment at all times. Maintain the interior of plant at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows, or other access openings to brief periods as necessary for rigging purposes. Storm water or ground water leakage is prohibited. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all equipment being operated by VA. Maintain all egress routes and safety systems/devices.
- F. Acceptance of Work for Government Operation: As new equipment, systems and facilities are made available for operation and these items are deemed 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. No boiler, system, or piece of equipment will be accepted for beneficial use until ALL safety devices have been tested and passed in accordance with the VHA Boiler Plant Safety Devices Testing Manual; all equipment that requires regular maintenance, calibration, etc. are accessible from the floor or permanent work platform; and all control systems are proven to be fully operational without faults or shutdowns for a period not less than 21 days of continuous operation without interaction from any person other than that of normal operational duty. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
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. Equipment and components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a nameplate 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 must be approved by the VA but may be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3 BELT DRIVES

- A. Type: ARPM standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating, and selection standards: ARPM IP-20 and ARPM IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ARPM service factor (not less than 20 percent) in addition to the ARPM allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ARPM standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ARPM specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
1. Material: Pressed steel, or close-grained cast iron.

2. Bore: Fixed or bushing type for securing to shaft with keys.
3. Balanced: Statically and dynamically.
4. Groove spacing for driving and driven pulleys shall be the same.
5. Minimum Diameter of V-Belt Sheaves (ARPM recommendations) in millimeters and inches:

I. Drive Types, Based on ARI 435:

1. Provide adjustable-pitch drive as follows:
 - a. Fan speeds up to 1800 RPM: 7.5 kW (10 hp) and smaller.
 - b. Fan speeds over 1800 RPM: 2.2 kW (3 hp) and smaller.
2. Provide fixed-pitch drives for drives larger than those listed above.
3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling the design air flow branch, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

J. Final Drive Set: If adjustment is required beyond the capabilities of the factory drive set, the final drive set shall be provided as part of this contract at no additional cost or time to the Government.

2.4 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears, and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory-fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; all edges shall be hemmed, and ends shall be bent into flanges and the flanges 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, and non-resonant. Guard shall be an assembly of minimum 22-gauge sheet steel and expanded or perforated metal to permit observation of belts.

25 mm (1 inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.

- D. Materials: Sheet steel, 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 (1 inch) diameter hole at each shaft center.

2.5 LIFTING ATTACHMENTS

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.6 ELECTRIC MOTORS

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, 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.

2.7 VARIABLE SPEED MOTOR CONTROLLERS

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR CONTROLLERS for specifications.
- B. Coordinate variable speed motor controllers' communication protocol with Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- C. Provide variable speed motor controllers with or without a bypass contactor as indicated in Contract drawings.
- D. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps shall be product of a single manufacturer.
- E. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be

guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.

- F. Controller shall not add any current or voltage transients to the input ac power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the ac power system.

2.8 TEMPORARY BOILER PLANT INSTALLATION

- A. Existing temporary boiler shall remain for the duration of this project. Minor alterations to boiler piping may be required during replacement of the boiler headers.

2.9 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the contract documents, and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 5 mm (3/16 inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 5 mm (3/16 inch) high riveted or bolted to the equipment.
- D. Control Items: Label all instrumentation, temperature and humidity sensors, controllers, and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
 - 1. Boiler Plant: Provide for all valves.
 - 2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 6 mm (1/4 inch) for service designation on 19-gauge 40 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 215 mm (8-1/2 inches) by 275 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color-coded thumb tack in ceiling.

2.10 FIRESTOPPING

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke, and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.11 GALVANIZED REPAIR COMPOUND

- A. Mil-P-21035B, paint form.

2.12 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Vibration Isolators: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- B. Pipe Hangers and Supports for Boiler Plant: Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- C. Supports for Roof Mounted Items:
 1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 by 100 mm (2 by 4 inches) 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 275 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
 2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
- D. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- E. Attachment to Concrete Building Construction:
 1. Concrete insert: MSS SP-58, Type 18.

2. Self-drilling expansion shields and machine bolt expansion anchors:
Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- F. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
 2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- 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/A36M or ASTM 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 40 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 by 41 mm (1-5/8 by 1-5/8 inches), 2.7 mm (12 gauge), designed to accept special spring held, hardened steel nuts. Prohibited for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91 kg (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 15 mm (1/2 inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- K. Supports for Piping Systems:
1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate

- shield at all other types of supports and hangers including those for preinsulated piping.
2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.
 - c. Wall brackets: Types 31, 32 or 33.
 - d. Roller supports: Type 41, 43, 44 and 46.
 - e. Saddle support: Type 36, 37 or 38.
 - f. Turnbuckle: Types 13 or 15. Preinsulated.
 - g. U-bolt clamp: Type 24.
 - h. Copper Tube:
 - 1) Hangers, clamps, and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
 - 2) For vertical runs use epoxy painted or plastic-coated riser clamps.
 - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
 - i. Supports for plastic piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
 3. High and Medium Pressure Steam (MSS SP-58):
 - a. Provide eye rod or Type 17 eye nut near the upper attachment.
 - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger.
 - c. Piping with Vertical Expansion and Contraction:
 - 1) Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
 - 2) Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
 4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

L. Pre-insulated Calcium Silicate Shields:

1. Provide 360-degree water resistant high density 965 kPa (140 psig) 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 25 mm (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-58. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) 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.

2.13 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 (1 inch) above finished floor and provide sealant for watertight joint.
 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations through beams or ribs are prohibited 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, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo, or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.14 PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork, and equipment. Curbs shall be 457 mm (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.

2.15 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 (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.16 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 75 mm (3-inch pipe), 0.89 mm (0.035 inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls, and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.17 ASBESTOS

- A. Materials containing asbestos are prohibited.

PART 3 - EXECUTION**3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. The coordination/shop drawings shall be submitted for review. Locate piping, sleeves, inserts, hangers, ductwork, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Equipment coordination/shop drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review. 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 gauges 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 contract documents.
- 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 for all boilers on the aisle. Panels mounted on the sides near the front of fire tube boilers are prohibited.
- D. Boiler and Economizer Access Platforms: Arrange piping and equipment to allow access by a person standing on the platforms to all valves located above the boilers, to boiler manways located on top of the boilers, and to all economizer valves and access panels.
- E. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- F. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- G. Cutting Holes:
 - 1. Cut holes through concrete and masonry by rotary core drill.
Pneumatic hammer, impact electric, and hand or manual hammer type

- drill is prohibited, except as permitted by COR where working area space is limited.
2. Locate holes to avoid interference with structural members such as slabs, columns, ribs, beams or reinforcing. 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.
- H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- I. Electrical Interconnection of Instrumentation or Controls: 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. Devices shall be located so they are easily accessible for testing, maintenance, calibration, etc. The COR has the final determination on what is accessible and what is not. 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 non-shrink grout 21 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- L. Install gauges, thermometers, valves, and other devices with due regard for ease in reading or operating and maintaining said devices. Locate

and position thermometers and gauges to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

- M. Install steam piping expansion joints as per manufacturer's recommendations.
- N. Work in Existing Building:
1. Perform as specified in paragraph, OPERATIONS AND STORAGE AREAS, paragraph, ALTERATIONS, and paragraph, 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, paragraph, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
- O. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and data/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 to a height of 1.8 m (6 feet) above the equipment or to ceiling structure, whichever is lower (NFPA 70).
- P. Inaccessible Equipment:
1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance or inspections, equipment shall be removed, and reinstalled or remedial action performed as directed at no additional cost or time 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, but not limited to motors, fans, pumps, belt guards, transformers, high voltage lines, conduit and raceways, piping, hot surfaces, and ductwork. The COR has final determination on whether an installation meets this requirement or not.

3.3 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, ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING 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.

3.4 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 requirements 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. Follow approved rigging plan.
- G. Restore building to original condition upon completion of rigging work.

3.5 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels designed by a structural engineer, 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 pipe supports; wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above are prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Hanger rods shall be used 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-58. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
 - 1. Up to 150 mm (6 inch) pipe, 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
 - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
 - 3. Tubing and capillary systems shall be supported in channel troughs.
- G. Floor Supports:
 - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping.
Concrete bases and structural systems shall be anchored and doweled

- to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Structural contract documents shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

3.6 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the contract documents, 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. Debris accumulated in the area to the detriment of plant operation is prohibited. 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 VAMC, and Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.

- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with contract documents where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the contract documents of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All indicated valves including gate, globe, ball, butterfly and check, all pressure gauges 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 contract documents. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

3.7 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment, and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
 2. The following material and equipment shall not be painted:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.

- e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel, and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gauges and thermometers.
 - j. Glass.
 - k. Nameplates.
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 paint type and color as utilized by the pump manufacturer
 5. Boilers, Burners, Fuel Trains and Accessories: Retain manufacturer's factory finish. Touch up or recoat as necessary to provide smooth, even-colored, and even-textured finish.
 6. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats. This may include painting exposed metals where hangers were removed or where equipment was moved or removed.
 7. Paint shall withstand the following temperatures without peeling or discoloration:
 - a. Boiler Stack and Breeching: 65 degrees C (150 degrees F) on insulation jacket surface and 315 degrees C (600 degrees F) on metal surface of stacks and breeching.
 - b. Condensate and Feedwater 38 degrees C (100 degrees F) on insulation jacket surface and 121 degrees C (250 degrees F) on metal pipe surface.
 - c. Steam: 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (374 degrees F) on metal pipe surface.
 8. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.
 9. Lead based paints are prohibited.

3.8 IDENTIFICATION SIGNS

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, designating functions, for all equipment,

switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Boiler Plant Instrumentation Panel: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- D. Boiler Control Panels: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT
- E. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.9 MOTOR AND DRIVE ALIGNMENT

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- B. Direct-Connect Drive: Securely mount motor in accurate alignment so that shafts are per coupling manufacturer's tolerances when both motor and driven machine are operating at normal temperatures.

3.10 LUBRICATION

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. Field-check all devices for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings or devices. A minimum of 0.95 liter (1 quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided; also provide 12 grease sticks for lubricated plug valves. All materials shall be delivered to COR in unopened containers that are properly identified as to application.
- C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- D. All lubrication points shall be extended to one side of the equipment.

3.11 STARTUP, TEMPORARY OPERATION AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the

various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and Contractor testing of selected equipment. Coordinate the startup and Contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Startup of equipment shall be performed as described in equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.12 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, paragraph, TESTS; Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT; and in individual Division 23 specification sections 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 or time 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 conduct such performance tests and finalize control settings for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
- D. No adjustments maybe made during the acceptance inspection. All adjustments shall have been made by this point.
- E. Perform tests as required for commissioning provisions in accordance with Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

3.13 DEMONSTRATIONS AND TESTS, TEMPORARY BOILER PLANT EQUIPMENT

- A. Test prior to placing in service.
- B. Demonstrate to COR the proper operation of all equipment, instruments, operating and safety controls, and devices.
- C. Demonstrate to COR the proper operation of burners.
 - 1. Emissions within limits specified for new boilers on this project.
 - 2. Stable flame at all operating points with no pulsations.
 - 3. No flame impingement on the Morrison tube or furnace walls, or water tubes.
 - 4. Smooth flame light off, with no delays, puffs, or flashbacks.
 - 5. Turndown capability as specified.
- D. Develop full steam output capacity required.
- E. New boilers installed in temporary location:
 - 1. Perform all tests required by boiler specification.
 - 2. Perform complete retest after boiler is placed in its permanent location.

3.14 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.15 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 16 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

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**SECTION 23 05 12
GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- H. Section 26 24 19, MOTOR CONTROL CENTERS.
- I. Section 26 29 11, MOTOR CONTROLLERS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Bearing Manufacturers Association (ABMA):
 - 9-2015Load Ratings and Fatigue Life for Ball Bearings
 - 11-2014Load Ratings and Fatigue Life for Roller Bearings
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - 90.1-2013Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
- D. Institute of Electrical and Electronics Engineers (IEEE):
 - 112-2017Standard Test Procedure for Polyphase Induction Motors and Generators

841-2009IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors--Up to and Including 370 kW (500 hp)

E. National Electrical Manufacturers Association (NEMA):

MG 1-2019Motors and Generators

MG 2-2014Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

250-2014Enclosures for Electrical Equipment (1000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-2014National Electrical Code (NEC)

1.4 SUBMITTALS

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT", with applicable paragraph identification.

C. Submit motor submittals with driven equipment.

D. Shop Drawings:

1. Provide documentation to demonstrate compliance with contract documents.

2. Motor nameplate information shall be submitted including electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.

E. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.

- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Certification: Two weeks prior to final inspection, unless otherwise noted, certification shall be submitted to the COR stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.
- H. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

PART 2 - PRODUCTS

2.1 MOTORS

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- B. For severe duty TEFC motors, IEEE 841 shall apply.
- C. All material and equipment furnished, and installation methods shall conform to the requirements of Section 26 29 11, MOTOR CONTROLLERS; and 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 premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.

- D. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
 - 1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- F. Voltage ratings shall be as follows:
 - 1. Single phase:
 - a. Motors connected to 120-volt systems: 115 volts.
 - b. Motors connected to 208-volt systems: 200 volts.
 - c. Motors connected to 240-volt or 480-volt systems: 230/460 volts, dual connection.
 - 2. Three phase:
 - a. Motors connected to 208-volt systems: 200 volts.
 - b. Motors, less than 74.6 kW (100 hp), connected to 240-volt or 480-volt systems: 208-230/460 volts, dual connection.
 - c. Motors, 74.6 kW (100 hp) or larger, connected to 240-volt systems: 230 volts.
 - d. Motors, 74.6 kW (100 hp) or larger, connected to 480-volt systems: 460 volts.
 - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA MG 1 for connection to the nominal system voltage shown on the drawings.
- G. Number of phases shall be as follows:
 - 1. Motors, less than 373 W (1/2 hp): Single phase.
 - 2. Motors, 373 W (1/2 hp) and larger: 3 phase.
 - 3. Exceptions:
 - a. Hermetically sealed motors.

- b. Motors for equipment assemblies, less than 746 W (1 hp), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- H. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration, and running torque without exceeding nameplate ratings or considering service factor.
- J. Motor Enclosures:
 - 1. Shall be the NEMA types as specified and/or shown in the Contract Documents.
 - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
 - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
 - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
 - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
 - 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- K. Electrical Design Requirements:
 - 1. Motors shall be continuous duty.
 - 2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
 - 3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (176 degrees F).
 - 4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.

5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General-Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both, or NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors.

L. Mechanical Design Requirements:

1. Bearings shall be rated in accordance with ABMA 9 or ABMA 11 for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hours rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

M. Special Requirements:

1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional cost or time to the Government.
 2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
 3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
 - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
 - c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
 4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
 5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- N. Additional requirements for specific motors, as indicated in the other sections listed in Article, RELATED SECTIONS shall also apply.
- O. NEMA Premium Efficiency Electric Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 W (1 hp) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 W (1 hp) or more with open, drip-proof, or TEFC enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or

overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled (TEFC)			
Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM	Rating kW (hp)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

- P. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM, and 3600 RPM. Power factor correction capacitors shall be provided unless the motor meets the 0.90 requirement without it or if the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.
- Q. Energy Efficiency of Small Motors (Motor Efficiencies): All motors under 746 W (1 hp) shall meet the requirements of the DOE Small Motor Regulation.

Polyphase Open Motors Average full load efficiency				Capacitor-start capacitor-run and capacitor-start induction run open motors Average full load efficiency			
Rating kW (hp)	6 poles	4 poles	2 poles	Rating kW (hp)	6 poles	4 poles	2 poles
0.18 (0.25)	67.5	69.5	65.6	0.18 (0.25)	62.2	68.5	66.6
0.25 (0.33)	71.4	73.4	69.5	0.25 (0.33)	66.6	72.4	70.5
0.37 (0.5)	75.3	78.2	73.4	0.37 (0.5)	76.2	76.2	72.4
0.55 (0.75)	81.7	81.1	76.8	0.55 (0.75)	80.2	81.8	76.2

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.
- B. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 FIELD TESTS

- A. All tests shall be witnessed by the Commissioning Agent or by the COR.
- B. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.
- C. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- D. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- E. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

3.3 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.4 COMMISSIONING)

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for one hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

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**SECTION 23 05 51
NOISE AND VIBRATION CONTROL FOR BOILER PLANT**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the application of noise control measures, and vibration control techniques to boiler plant rotating equipment including pumps, fans, compressors, motors and steam turbines.
- B. A complete listing of all common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
- I. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Boiler Manufacturers Association (ABMA):
304-1995Measurement of Sound from Steam Generators
- C. American Society of Civil Engineers (ASCE):
7-2016Minimum Design Loads for Buildings and Other Structures
- D. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
Fundamentals-2017ASHRAE Handbook - Fundamentals, Chapter 8 Sound and Vibration

- E. American Society for Testing and Materials (ASTM):
 - A307-2019Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
 - B117-2018Standard Practice for Operating Salt Spray (Fog) Apparatus
 - D2240-2015Standard Test Method for Rubber Property - Durometer Hardness
- F. Associated Air Balance Council (AABC):
 - 2015National Standards for Total System Balance, 7th Edition
- G. International Code Council (ICC):
 - IBC-2018International Building Code
- H. International Standards Organization (ISO):
 - 1940-1-2003Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
- I. National Environmental Balancing Bureau (NEBB):
 - 2015Procedural Standard for the Measurement of Sound and Vibration, 3rd Edition
- J. Manufacturers Standardization (MSS):
 - SP-58-2018Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
- K. Occupational Safety and Health Administration (OSHA):
 - 29 CFR 1910.95Occupational Noise Exposure
- L. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
 - 001-2008Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition
- M. Department of Veterans Affairs (VA):
 - H-18-8-2019Seismic Design Requirements

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT", with applicable paragraph identification.
- C. Include noise and vibration control devices with the equipment submittals.
- D. Certification, training, and project experience resume of field shaft alignment and or dynamic machine balancing technicians.
- E. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Noise Criteria:
1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Conference Rooms	35
Locker Rooms	45
Offices, Large Open	40

TYPE OF ROOM	NC LEVEL
Offices, Small Private	35
Shops	50
Warehouse	50

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 8, Sound and Vibration.
 3. An allowance, not to exceed 5 dB, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
 4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.
- B. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm/s (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.
- C. AABC OR NEBB certified vibration and sound measurement professional shall certify final measurements. See Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions

shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
 - 1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data

on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the Selection Guide for Vibration Isolators Table at the end of this section of specifications.
- B. Elastomeric isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- C. Exposure to Weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition, provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with Section 1609 of the International Building Code (IBC). A minimum wind velocity of 120 km/h (75 mph) shall be employed.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENT (NOT USED)

2.3 VIBRATION ISOLATORS

- A. Floor Mountings:
 - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
 - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.

3. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 psig).
 4. Seismic Pad (Type DS): Pads shall be natural rubber/neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 psig).
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15-degree angular misalignment without rubbing on hanger box.
 2. Spring Position Hanger (Type HP): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15-degree angular misalignment without rubbing on hanger box. Hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
 3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
 4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15-degree angular misalignment without rubbing on hanger box.

5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
 6. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed 6 mm (1/4 inch) clear of bottom of hanger housing in operation to prevent spring from excessive upward travel.
- C. Snubbers: Each spring mounted base shall have a minimum of four all directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3.2 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

2.4 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (4 inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating pre-located equipment anchor bolts and pipe sleeves. Level the concrete

to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest base dimension but not less than 150 mm (6 inches). Form shall include 15 mm (1/2 inch) reinforcing bars welded in place on minimum of 200 mm (8 inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 1.6 mm (1/16 inch).

- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Vibration Isolation:
1. No metal-to-metal contact will be permitted between fixed and floating parts.
 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports with a deflection equal to that used on the corresponding equipment.
 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.

4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
 5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
 6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.
- C. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2 ADJUSTING

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 6 mm (1/4 inch) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

3.3 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT

- A. Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values required by 29 CFR 1910.95. Level and anchor equipment as necessary to achieve and maintain alignment. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION and Section 23 21 11, BOILER PLANT PIPING SYSTEMS. Work shall comply with manufacturer's instructions and/or recommendations

and with ISO 1940-1 for the type of equipment which is Grade 6.3 for most equipment in the boiler plant.

3.4 VIBRATION TESTS ON ROTATING EQUIPMENT

- A. Perform vibration tests on all pumps, fans, compressors and drivers during the pretest of the equipment. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT. Contractor shall notify COR at least 10 working days prior to commencing test. Tests shall be conducted by an experienced technician in the presence of the COR.
- B. Perform tests at each bearing in axial, horizontal, and vertical positions.
- C. rms vibration velocity shall not exceed 0.0025 m/s (0.10 inch per second). Correct the cause of excessive vibration and provide retest.
- D. Test instruments furnished by contractor:
 - 1. Portable with output capability to print data.
 - 2. Frequency range, 600 to 150,000 CPM minimum.
 - 3. Amplitude range, 0 to 2.54 m/s (0 to 100 inches per second).
 - 4. Sensitivity, 0.00013 m/s (0.005 inch per second).
 - 5. Frequency filter "out" for tests.
- E. Submit tabulated vibration readings to the COR.

3.5 SOUND LEVELS

- A. Sound level limitations apply to all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, motors, and turbines.
- B. Sound levels shall not exceed 85 dB(A) when measured 1375 mm (4.5 feet) above the floor and 900 mm (3 feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.
- C. Tests will be performed by the Government using a standard sound level meter on the "A" scale, slow response. At the option and expense of the Government, a testing company may be employed to conduct tests using methods conforming to ABMA 304.
- D. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.

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1. Submit all proposed modifications or replacements for review prior to starting the work.
2. After completing the work, provide complete retest of equipment operation and performance.

3.6 COMMISSIONING (NOT)

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.7 SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
COMPRESSORS AND VACUUM PUMPS																
UP THROUGH 1-1/2 HP		---	D, L, W	0.8	----	D, L, W	0.8	---	D, L, W	1.5	---	D, L, W	1.5	---	D, L, W	---
2 HP AND OVER:																
500 - 750 RPM		---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5
750 RPM & OVER		---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5
PUMPS																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---
	2 HP & OVER	---	---	---	I	S	0.8	I	S	1.5	I	S	1.5	I	S	2.0
LARGE INLINE	Up to 25 HP	---	---	---	---	S	0.75	---	S	1.50	---	S	1.50	---	---	NA
	26 HP THRU 30 HP	---	---	---	---	S	1.0	---	S	1.50	---	S	2.50	---	---	NA
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---
	15 HP THRU 40 HP	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.0	I	S	2.0

EQUIPMENT		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.5	I	S	2.5
ROOF FANS																
ABOVE OCCUPIED AREAS:																
	5 HP & OVER	---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
CENTRIFUGAL FANS																
UP TO 50 HP:																
	UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
	201 - 300 RPM	B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
	301 - 500 RPM	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
	501 RPM & OVER	B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5
60 HP & OVER:																
	UP TO 300 RPM	B	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
	301 - 500 RPM	B	S	2.0	I	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5
	501 RPM & OVER	B	S	1.0	I	S	2.0	I	S	2.0	I	S	2.5	I	S	2.5
INTERNAL COMBUSTION ENGINES																
	UP TO 25 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
	30 THRU 100 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
	125 HP & OVER	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
AIR HANDLING UNIT PACKAGES																

EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
SUSPENDED:															
UP THRU 5 HP	---	---	---	---	H	1.0	---	H	1.0	---	H	1.0	---	H	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	---	---	---	H, THR	1.5	---	H, THR	2.5	---	H, THR	2.5	---	H, THR	2.5
501 RPM & OVER	---	---	---	---	H, THR	0.8	---	H, THR	0.8	---	H, THR	0.8	---	H, THR	2.0
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.5	R	S, THR	2.5	R	S, THR	2.5	R	S, THR	2.5
501 RPM & OVER	---	D	---	---	S, THR	0.8	---	S, THR	0.8	R	S, THR	1.5	R	S, THR	2.0
HEAT PUMPS															
ALL	---	S	0.75	---	S	0.75	---	S	0.75	CB	S	1.5	---	---	NA
CONDENSING UNITS															
ALL	---	SS	0.25	---	SS	0.75	---	SS	1.5	CB	SS	1.5	---	---	NA
IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED:															
UP THRU 50 HP:															
UP TO 300 RPM	---	D	---	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301 - 500 RPM	---	D	---	R	S	2.0	R	S	2.0	R	S	2.5	R	S	2.5

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EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	2.0	R	S	2.5
60 HP AND OVER:															
301 - 500 RPM	R	S	1.0	R	S	2.0	R	S	2.0	R	S	2.5	R	S	3.5
501 RPM & OVER	R	S	1.0	R	S	2.0	R	S	2.0	R	S	2.0	R	S	2.5

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SECTION 23 07 11
HVAC AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for
1. HVAC piping, ductwork, and equipment.
 2. Boiler plant mechanical systems including burner propane storage and handling facilities but excluding outside steam distribution.
- B. Definitions
1. ASJ: All service jacket, white finish facing or jacket.
 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
 3. Cold: Equipment, ductwork, or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 6. FSK: Foil-scrim-kraft facing.
 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F); Boiler Plant breechings and stack temperature range 150-370 degrees C (300-700 degrees F) and piping media and equipment 32 to 230 degrees C (90 to 450 degrees F).
 8. Density: kg/m^3 - kilograms per cubic meter (PCF - pounds per cubic foot).
 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
 10. Thermal conductance: Heat flow rate through materials.
 - a. Flat surface: Watt per square meter (BTU per hour per square foot).

- b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).
11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
 12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
 13. HPS: High pressure steam (415 kPa [60 psig] and above).
 14. HPR: High pressure steam condensate return.
 15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
 16. MPR: Medium pressure steam condensate return.
 17. LPS: Low pressure steam (103 kPa [15 psig] and below).
 18. LPR: Low pressure steam condensate gravity return.
 19. PC: Pumped condensate.
 20. HWH: Hot water heating supply.
 21. HWHR: Hot water heating return.
 22. GH: Hot glycol-water heating supply.
 23. GHR: Hot glycol-water heating return.
 24. FWPD: Feedwater pump discharge.
 25. FWPS: Feedwater pump suction.
 26. CTPD: Condensate transfer pump discharge.
 27. CTPS: Condensate transfer pump suction.
 28. VR: Vacuum condensate return.
 29. CPD: Condensate pump discharge.
 30. R: Pump recirculation.
 31. FOS: Fuel oil supply.
 32. FOR: Fuel oil return.
 33. CW: Cold water.
 34. SW: Soft water.
 35. HW: Hot water.
 36. CH: Chilled water supply.

- 37. CHR: Chilled water return.
- 38. GC: Chilled glycol-water supply.
- 39. GCR: Chilled glycol-water return.
- 40. RS: Refrigerant suction.
- 41. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 07 84 00, FIRESTOPPING.
- C. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- D. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- E. Section 23 21 11, BOILER PLANT PIPING SYSTEMS
- F. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT
- G. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS

1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- B. Criteria:
 - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

4.3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2., shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-

Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

(1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors

(2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

(1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides

(2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials*

2. Test methods: ASTM E84, UL 723, or NFPA 255.
3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - a. Insulation materials: Specify each type used and state surface burning characteristics.
 - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings, and equipment.
 - c. Insulation accessory materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

e. Make reference to applicable specification paragraph numbers for coordination.

C. Samples:

- 1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
- 2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
- 3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

1.5 STORAGE AND HANDLING OF MATERIAL

A. Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 APPLICABLE PUBLICATIONS

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

B. Federal Specifications (Fed. Spec.):

L-P-535E (2)- 1999Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.

C. Military Specifications (Mil. Spec.):

MIL-A-3316C -1987 Adhesives, Fire-Resistant, Thermal Insulation

MIL-A-24179A (1)-2016 Adhesive, Flexible Unicellular-Plastic Thermal Insulation

MIL-C-19565C (1)- 2016 Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier

MIL-C-20079H-1987Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

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

A167-99 2014Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-2014	.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C411-2019	.....Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
C449-2019	.....Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
C533-2017	.....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
C534-2017...	.....Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C547-2017	.....Standard Specification for Mineral Fiber pipe Insulation
C552-07	.....Standard Specification for Cellular Glass Thermal Insulation
C553-2015	.....Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
C585-2016	.....Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)
C612-2014	.....Standard Specification for Mineral Fiber Block and Board Thermal Insulation
C1126-2019	.....Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
C1136-2017	.....Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
D1668-97a 2017	.....Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
E84-2014	.....Standard Test Method for Surface Burning Characteristics of Building Materials
E119-2007	.....Standard Test Method for Fire Tests of Building Construction and Materials

- E136-2019Standard Test Methods for Behavior of Materials
in a Vertical Tube Furnace at 750 degrees C
(1380 F)
- E. National Fire Protection Association (NFPA):
- 90A-2018Standard for the Installation of Air
Conditioning and Ventilating Systems
- 96-2018Standards for Ventilation Control and Fire
Protection of Commercial Cooking Operations
- 101-2018Life Safety Code
- 251-2014Standard methods of Tests of Fire Endurance of
Building Construction Materials
- 255-2006Standard Method of tests of Surface Burning
Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
- 723-2018UL Standard for Safety Test for Surface Burning
Characteristics of Building Materials with
Revision of 09/08
- G. Manufacturer's Standardization Society of the Valve and Fitting
Industry (MSS):
- SP58-2018Pipe Hangers and Supports Materials, Design,
and Manufacture

PART 2 - PRODUCTS

2.1 MINERAL FIBER OR FIBER GLASS

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m³ (3 PCF), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 32 kg/m³ (2 PCF), k = 0.04 (0.27) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2.2 MINERAL WOOL OR REFRACTORY FIBER

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

2.3 RIGID CELLULAR PHENOLIC FOAM

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1, $k = 0.021(0.15)$ at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, $k = 0.021(0.15)$ at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket.

2.4 CELLULAR GLASS CLOSED-CELL

- A. Comply with Standard ASTM C177, C518, density 120 kg/m³ (7.5 PCF) nominal, $k = 0.033(0.29)$ at 24 θ degrees C (75 degrees F).
- B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

2.5 POLYISOCYANURATE CLOSED-CELL RIGID

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV, $K=0.027(0.19)$ at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, type IV, $K=0.027(0.19)$ at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

- A. ASTM C177, C518, $k = 0.039(0.27)$ at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.7 DUCT WRAP FOR KITCHEN HOOD GREASE DUCTS (NOT USED)**2.8 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

C. Equipment Insulation: ASTM C533, Type I and Type II

D. Characteristics:

Insulation Characteristics		
ITEMS	TYPE I	TYPE II
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m ³ (lb/ ft ³)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft ² degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.9 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance ≤ 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings, and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork

as well as on interior piping and ductwork exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- E. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- H. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- I. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

2.10 REMOVABLE INSULATION JACKETS

- A. Insulation and Jacket:
 - 1. Non-Asbestos Glass mat, type E needled fiber.

2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

2.11 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 PCF).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 PCF).
- C. Boiler Plant Pipe supports: MSS SP58, Type 39. Apply at all pipe support points, except where MSS SP58, Type 3 pipe clamps provided as part of the support system.

2.12 ADHESIVE, MASTIC, CEMENT

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.

- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

2.13 MECHANICAL FASTENERS

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching Monel or galvanized steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum, or stainless steel.

2.14 REINFORCEMENT AND FINISHES

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

2.15 FIRESTOPPING MATERIAL

- A. Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.16 FLAME AND SMOKE

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION**3.1 GENERAL REQUIREMENTS**

- A. Provide removable lagging pads for the following existing equipment.
1. #3 boiler
 - a. Steam Stop Valve
 - b. Steam Stop/Check Valve
 2. DA/Condensate deck
 - a. 75 psi PRV and downstream Valve
 3. Main Floor
 - a. MAU condensate trap and valves
 4. Basement
 - a. #2B condensate pump discharge valve
 - b. Medium pressure meter
 - c. Medium pressure blanked valve
 - d. Medium pressure isolation valve
 - e. High pressure blanked valve
 - f. High pressure isolation valve
 - g. High pressure meter
 - h. Water meter
- B. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the COR for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- C. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and

uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

- E. Install vapor stops at all insulation terminations on either side of valves, pumps, and equipment and particularly in straight lengths of pipe insulation.
- F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- G. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- I. Insulate PRVs, flow meters, and steam traps.
- J. Boiler plant work not to be insulated (NI) or if insulated the insulation shall be removal jacket type (RJ):
 - 1. Pipes, valves, and fittings:
 - a. Gas fuel (NI)
 - b. Compressed Air (NI)
 - c. Flowmeter sensing piping and blowdown (NI)
 - d. Level sensor piping and blowdown (NI)
 - e. Tank drains (NI)
 - f. Vents-tank, safety, and back pressure valves except protective.
(NI)
 - g. Continuous blowdown and boiler water sampling except protective.
(NI)
 - h. Threaded valves (RJ)

- i. Check valves (RJ)
 - j. Unions (RJ)
 - k. Orifice flanges (RJ)
 - l. Dielectric flanges and unions (RJ)
 - m. Steam header drains (NI)
 - n. Non-return stop and check valve drains (NI)
 - o. Pneumatic controls (NI)
 - p. Pressure transmission to gages (NI)
 - q. Piping in control panels (NI)
 - r. Tube cleaning piping (NI)
 - s. Chemical feed from pump-type feeders (NI)
 - t. Condensate piping from flash tank to condensate return pump (NI)
2. Boilers:
- a. Water column, piping, and blowdown (NI)
 - b. Auxiliary low water cutoff, piping, and blowdown (NI)
 - c. Remote water level indicators and piping blowdown (NI)
 - d. Steam gage piping (NI)
 - e. Safety valves and drip pan ells (NI)
 - f. Water level sensors and piping except where required by equipment manufacturer (NI)
 - g. Control piping and devices or interlocks (NI)
3. Equipment:
- a. Condensate return pump units (NI)
 - b. Vacuum return pump units (NI)
 - c. Pumps-inlet to outlet (NI)
 - d. Flash tanks (NI)
 - e. Safety valves (NI)
 - f. Water meters (NI)
 - g. Oil meters (NI)
 - h. Air compressors and tanks (NI)
 - i. Refrigerated or desiccant air drier (NI)
 - j. Chemical feeders (NI)
 - k. Boiler and feedwater sampler (NI)
 - l. All nameplates (NI)
4. Specialties:
- a. Pressure reducing valves (RJ)

- b. Control valves-water and steam(NI)
 - c. Level sensors-piping, valves, and blowdown(NI)
 - d. Back pressure regulators-oil and steam(NI)
 - e. Strainers under 65 mm (2-1/2 inch) pipe size(RJ)
 - f. Expansion bellows(RJ)
 - g. Flexible connectors(RJ)
 - h. Ball joints except piping between joints(NI)
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic, and coatings at the manufacturer's recommended minimum coverage.
- L. Elbows, flanges, and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Firestop Pipe and Duct insulation:
- 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
 - 2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
 - a. Pipe risers through floors
 - b. Pipe or duct chase walls and floors
 - c. Smoke partitions
 - d. Fire partitions
- N. Freeze protection of above grade outdoor piping (over heat tracing tape): 26 mm (10 inch) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes.
- O. Provide vapor barrier jackets over insulation as follows:
- 1. All piping and ductwork exposed to outdoor weather.
 - 2. All interior piping and ducts conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.) below ambient air temperature.
- P. Provide metal jackets over insulation as follows:

1. All piping and ducts exposed to outdoor weather.
2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen, and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling, or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION (NOT USED)

3.3 APPLICATION -BOILER PLANT, PIPE, VALVES, STRAINERS AND FITTINGS:

- A. Temperature range 120 to 230 degrees C (251 to 450 degrees F).
1. Application: Steam service 110 kPA (16 psig nominal) and higher, high pressure condensate to trap assembly, boiler bottom blowoff from boiler to blowoff valve closest to boiler.
 2. Insulation and Jacket:
 - a. Calcium silicate for piping from zero to 1800 mm (6 feet) above boiler room floor, feedwater heater mezzanine floor or access platform and any floors or platforms on which tanks or pumps are located.
 - b. Mineral fiber for remaining locations.
 - c. ASJ with PVC premolded fitting coverings.
 - d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on atomizing steam and condensate lines at boilers and burners.
 3. Thickness:

Nominal Thickness of Calcium Silicate Insulation (Boiler Plant)	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	125 (5)
25 to 38 (1-1/4 to 1-1/2)	125 (5)
38 (1-1/2) and above	150 (6)

- B. Temperature range 100 to 121 degrees C (211 to 250 degrees F):
1. Application: Steam service 103 kPA (15 psig) and below, trap assembly discharge piping, boiler feedwater from feedwater heater to

boiler feed pump recirculation, feedwater heater overflow, heated oil from oil heater to burners.

2. Insulation and Jacket:

- a. Calcium silicate for piping from zero to 1800 mm (0 to 6 feet) above boiler room floor, feedwater heater mezzanine floor and access platform, and any floors or access platforms on which tanks or pumps are located.
- b. Mineral Fiber or rigid closed cell phenolic foam for remaining locations.
- c. ASJ with PVC premolded fitting coverings.
- d. Aluminum jacket from zero to 1800 mm (6 feet) above floor on condensate lines at boilers and burners.

3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	50 (2)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)

4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	38 (1.5)
38 (1-1/2) and above	75(3)

C. Temperature range 32 to 99 degrees C (90 to 211 degrees F):

1. Application: Pumped condensate, vacuum heating return, gravity and pumped heating returns, condensate transfer, condensate transfer pump recirculation, heated oil system to heaters and returns from burners, condensate return from convertors and heated water storage tanks.
2. Insulation Jacket:

- a. Calcium silicate for piping from zero to 1800 mm (six feet above boiler room floor, feedwater heater mezzanine floor and access platform and any floor or access platform on which tanks or pumps are located.
 - b. Mineral fiber or rigid closed-cell phenolic foam for remaining locations.
 - c. ASJ with PVC premolded fitting coverings.
3. Thickness-calcium silicate and mineral fiber insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	38 (1.5)
25 to 38 (1-1/4 to 1-1/2)	50 (2)
38 (1-1/2) and above	75 (3)

- D. 4. Thickness-rigid closed-cell phenolic foam insulation:

Nominal Thickness of Insulation	
Pipe Diameter mm (in)	Insulation Thickness mm (in)
25 (1 and below)	19 (0.75)
25 to 38 (1-1/4 to 1-1/2)	19 (0.75)
38 (1-1/2) and above	25 (1)

- E. Protective insulation to prevent personnel injury:
- 1. Application: Piping from zero to 1800 mm (6 feet) above all floors and access platforms including continuous blowoff, feedwater and boiler water sample, blowoff tank vent, flash tank vents and condensate tank vent, shot-type chemical feed, fire tube boiler bottom blowoff after valves, valve by-passes.
 - 2. Insulation thickness: 25 mm (1 inch).
 - 3. Insulation and jacket: Calcium silicate with ASJ except provide aluminum jacket on piping at boilers within 1800 mm (6 feet) of floor. Use PVC premolded fitting coverings when all service jacket is utilized.
- F. Installation:
- 1. At pipe supports, weld pipe covering protection saddles to pipe, except where MS-SP58, type 3 pipe clamps are utilized.

2. Insulation shall be firmly applied, joints butted tightly, mechanically fastened by stainless steel wires on 300 mm (12 inch) centers.
3. At support points, fill and thoroughly pack space between pipe covering protective saddle bearing area.
4. Terminate insulation and jacket hard and tight at anchor points.
5. Terminate insulation at piping facilities not insulated with a 45 degree chamfered section of insulating and finishing cement covered with jacket.
6. On calcium silicate, mineral fiber, and rigid closed-cell phenolic foam systems, insulated flanged fittings, strainers, and valves with sections of pipe insulation cut, fitted, and arranged neatly and firmly wired in place. Fill all cracks and voids, and coat outer surface with insulating cement. Install jacket. Provide similar construction on welded and threaded fittings on calcium silicate systems or use premolded fitting insulation.
7. On mineral fiber systems, insulate welded and threaded fittings more than 50 mm (2 inches) in diameter with compressed blanket insulation (minimum 2/1) and finish with jacket or PVC cover.
8. Insulate fittings 50 mm (2 inches) and smaller with mastic finishing material and cover with jacket.
9. Insulate valve bonnet up to valve side of bonnet flange to permit bonnet flange removal without disturbing insulation.
10. Install jacket smooth, tight, and neatly finish all edges. Over wrap ASJ butt strips by 50 percent. Secure aluminum jacket with stainless steel bands 300 mm (12 inches) on center or aluminum screws on 200 mm (4 inch) centers.
11. Do not insulate basket removal flanges on strainers.

3.4 APPLICATION-BOILER FLUE GAS SYSTEMS

- A. Temperature range 150 to 370 degrees C (300 to 700 degrees F):
 1. Application: Transitions, stacks, and breechings from boiler outlet to stack outlet; induced draft fans (if provided); flue gas recirculation fans and ductwork (if provided).
 2. Thickness:
 - a. Single-wall duct systems: 50 mm (2 inches).

- b. Double-wall factory-fabricated duct systems with air space between walls: None.
- 3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- B. Protective Insulation to Prevent Personnel Injury:
 - 1. Application: Double wall factory-fabricated duct system with uninsulated air space between walls within 900 mm (3 feet) horizontally and 1800 mm (6 feet) vertically of platform or floor.
 - 2. Insulation thickness; 25 mm (1 inch).
 - 3. Insulation and jacket: Calcium Silicate with aluminum sheet metal jacket.
- C. Insulating:
 - 1. Provide attachment facilities such as angles, welded studs, clip angles.
 - 2. Apply insulation with joints tightly butted and staggered. Seal joints with high temperature cement.
 - 3. Provide metal corner beads.
 - 4. Band insulation firmly in place to provide a smooth surface. Maximum band spacing shall not be more than 300 mm (12 inches).
 - 5. Install jacket. All surfaces outside of building must be weather tight. At termination of stub stacks, provide metal closure system which is connected and sealed to perimeter of stack to prevent water penetration of insulation.

3.5 APPLICATION-BOILER DEAERATING FEEDWATER HEATER, TANKS

- A. Reinsulate as required for access to spray head and safety devices.
- B. Temperature range 38 to 120 degrees C (100 to 250 degrees F)
 - 1. Application: Deaerating feedwater heater and storage tank, condensate storage tanks, heat exchangers, blowoff tank.
 - 2. Insulation Thickness:
 - a. Feedwater heater and storage tanks: 75 mm (3 inches)
 - b. Condensate storage tanks: 50 mm (2 inches)
 - c. Blowoff tank, heat exchangers: 25 mm (1 inch).
 - 3. Insulation and covering: Calcium silicate with glass cloth jacket.
- C. Insulating:
 - 1. Insulate tanks with an assembly of chamfered block to fit curvature. Secure with 1.6 mm diameter (16 gage) wire or stainless steel bands

300 mm (12 inches) on centers, fill all voids and interstices with finishing cement coat, imbed hexagonal wire mesh in first finish coat. Provide a second finish coat and a glass cloth covering.

2. Apply glass cloth with adhesive, smooth, tight, and neatly finished at all cloth edges; prime to receive paint.
3. Do not insulate over nameplates and data plates. Nameplates and data plates must be legible.

3.6 APPLICATION ON HEATED OR TRACED PROPANE FACILITIES OUTSIDE OF BUILDING

- A. Temperature range 30 to 120 degrees C (85 to 250 degrees F).
 1. Application: Aboveground propane storage tank piping.
 2. Insulation thickness:
 - a. Propane suction and return piping: 38 mm (1-1/2 inches plus finish).
- B. Insulation and jacket (aboveground tanks and piping): Calcium silicate with glass cloth or aluminum jacket, weatherproof jacket when used outside of building.
- C. Insulation and Jacket (underground piping); Calcium silicate with fiberglass scrim jacket located within secondary containment. Allow space for heating cable (if provided) along bottom line of piping.

3.7 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.8 PIPE INSULATION SCHEDULE (NOT USED)

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SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 33 00 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- D. Section 23 05 51 NOISE AND VIBRATION CONTROL for BOILER PLANT.
- E. Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- F. Section 23 09 11 INSTRUMENTATION AND CONTROL FOR BOILER PLANT

1.3 SUMMARY

- A. This Section includes requirements for commissioning the HVAC systems of the related subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00

GENERAL COMMISSIONING REQUIREMENTS and of Division 23, is required in cooperation with the VA and the Commissioning Agent.

- B. The Facility HVAC systems commissioning will include the systems listed in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.7 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. Department of Veterans Affairs (VA):
PG 18-10 2015Physical Security Design Manual
- C. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
HANDBOOK 2019HVAC Applications ASHRAE Handbook, Chapter 39, Testing, Adjusting, and Balancing, Chapter 44, HVAC Commissioning and Chapter 49, Sound and Vibration Control
HANDBOOK 2017HVAC Fundamentals ASHRAE Handbook, Chapter 8, Sound and Vibration
- D. Associated Air Balance Council (AABC):
7th Edition 2016AABC National Standards for Total System Balance
- E. National Environmental Balancing Bureau (NEBB):
9th Edition 2019Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

3rd Edition 2015Procedural Standards for the Measurement of
Sound and Vibration

S110-2019, 2nd Edition ...Whole Building Technical Commissioning of New
Construction

F. Sheet Metal and Air Conditioning Contractors National Association
(SMACNA):

006 2006...HVAC Duct Construction Standard - Metal and
Flexible Duct

3rd Edition 2005 ... HVAC Systems Testing, Adjusting and Balancing

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. Refer to Sections 23 05 51 NOISE AND VIBRATION CONTROL for BOILER PLANT, Section 23 08 11 DEMONSTRATIONS AND TESTS FOR BOILER PLANT and Section 23 09 11 INSTRUMENTATION AND CONTROL FOR BOILER PLANT requirements. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the

Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional requirements.

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with

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the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for additional Contractor training requirements.

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SECTION 23 08 11
DEMONSTRATIONS AND TESTS FOR BOILER PLANT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Procedures for onsite demonstration and testing of equipment and systems, including temporary facilities.
- B. Instruction of Government operating personnel.
- C. All demonstrations, instructions, access platforms, and testing must be completed prior to Government acceptance for beneficial use. All safety devices shall pass 100 percent before the boiler plant can be accepted for beneficial use.
- D. Plumbing and emergency power systems are not included.
- E. Definitions:
 - 1. 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.
 - 2. 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 COR is not required.
 - 3. Final Tests: Tests, witnessed by the COR or designated 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. If any portion of the final test fail and must be retested the Government shall receive a full credit for any expenses incurred for services from independent testing organizations or consultant services for all re-inspections or tests.
- F. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- F. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- I. Section 23 10 00, FACILITY FUEL SYSTEMS.
- J. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- K. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- L. Section 23 52 39, FIRE-TUBE BOILERS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. Department of Veterans Affairs (VA):
 - 2018VHA Boiler Plant Safety Devices Testing Manual, Fifth Edition
 - PG-18-10-2015Physical Security and Resiliency Design Manual

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT", with applicable paragraph identification.
- C. Names and qualifications of personnel performing demonstrations, instructions and tests.
- D. Certification that pre-testing is complete. Copies of boiler-burner and feedwater deaerator pre-test data as specified. Copies of the VHA Boiler Plant Safety Devices Testing Manual completely filled out with notes.
- E. Preliminary schedule of all demonstrations, instructions and final tests two weeks prior to proposed dates.
- F. 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.

- G. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Experienced, trained technical service personnel who are representatives of the equipment manufacturers and system designers shall demonstrate, provide instructions, pre-test and final test, as specified, the following equipment:
 - 1. Boilers and economizers
 - 2. Burners
 - 3. Control systems
 - 4. Instrumentation
 - 5. Deaerating feedwater heater
- B. Experienced technicians shall demonstrate and provide instructions on the following equipment:
 - 1. Pumps and piping systems
 - 2. Compressed air systems
 - 3. Control and safety valves
- C. The person responsible for programming the computer workstation shall demonstrate and provide instructions on hardware, software and programming.
- D. The COR, upon request, will provide a list of personnel to receive instructions and will coordinate their attendance at agreed upon times.
- E. All safety devices shall comply with the VHA Boiler Plant Safety Devices Testing Manual.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS

- A. Verify that equipment and systems are fully operational. Complete all start-up and pre-test activities for all equipment and systems. Complete all construction and finish work.

- B. Arrange for all test personnel for all equipment to be continuously present during one period of time so that all equipment and systems can be tested in their interrelated functions. For instance, feedwater deaerator will be tested during the boiler testing, and instrumentation performance will be evaluated in conjunction with boiler testing.
- C. Deliver maintenance and operating manuals four weeks prior to instruction period.
- D. Furnish all special tools.

3.2 FINAL TESTS

- A. Demonstrate proper operation of each equipment and system to include demonstration and testing of all safety devices.
- B. Provide tests on equipment as specified in the individual specification sections.

3.3 START-UP AND TESTING

- A. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.5 DEMONSTRATIONS AND TRAINING

- A. Demonstrate operation and maintenance of equipment and systems to Government personnel no more than four weeks prior to scheduled Government operation of the plant.
- B. Use operation and maintenance manuals, as-built drawings, and single line drawings as basis of instruction. Review contents of manuals and drawings with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut-down of each item of equipment. Allow

Government personnel to practice operating the equipment under supervision of instructors.

1. All demonstrations shall follow a contractor provided written step by step standard operating procedure.
 2. Demonstrate lockout/tagout locations for all equipment and hazards using a written procedure that clearly identifies lockout points (breakers, disconnects, valves, etc.) for each piece of equipment. Valves are to be identified by a valve tag number, breakers are by number located in breaker box number, disconnect location and number etc.
 3. Demonstrate the as-built drawings are correct and provide single line drawings for each system.
- 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 DVD.
- F. Provide services of manufacturer's technical representative to instruct VA personnel in operation and maintenance of units.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

3.6 TIME ALLOCATED FOR DEMONSTRATIONS AND INSTRUCTIONS

- A. At least 32 total instructor hours to include boilers, economizers, burners, burner controls, combustion controls, instrumentation.
- B. At least 16 total instructor hours to include computer workstation and programs.
- C. At least 8 total instructor hours to include pumps, steam turbine, feedwater deaerator, and other equipment.
- D. Do not exceed three trainees per session, one four-hour session, per day, per trainee.

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**SECTION 23 09 11
INSTRUMENTATION AND CONTROL FOR BOILER PLANT**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Automatic controls, instruments, monitoring and data management systems and accessories for the boilers, burners and other boiler plant mechanical equipment. The specification classifies the systems into automatic boiler and burner control systems, burner management systems (flame safeguard), and data management and instrumentation systems.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- F. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS
- H. Section 23 10 00, FACILITY FUEL SYSTEMS.
- I. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- J. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- K. Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
- L. Section 23 52 39, FIRE-TUBE BOILERS.
- M. Section 26 05 11, REQUIREMENTS for ELECTRICAL INSTALLATIONS.
- N. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- O. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- P. Section 26 27 26, WIRING DEVICES.
- Q. Section 26 29 11, MOTOR CONTROLLERS.

1.3 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. Where conflicts occur these specifications and the VHA standard shall govern.

- B. American National Standards Institute (ANSI):
INCITS 154-S2019Office Machines and Supplies - Alphanumeric
Machines - Keyboard Arrangement
- C. American Society of Mechanical Engineers (ASME):
B31.1-2014Power Piping
B40.100-2013Pressure Gauges and Gauge Attachments
PTC 4-2013Fired Steam Generators
- D. National Electrical Manufacturers Association (NEMA):
ICS 6-1993(R2006) Industrial Control and Systems: Enclosures
WC63.2-1996(R2003)Performance Standard for Coaxial Premise Data
Communications Cables
- E. National Fire Protection Association (NFPA):
70-2017National Electrical Code
85-2019Boiler and Combustion Systems Hazards Code
- F. Underwriters Laboratories Inc. (UL):
508-1999(R2018)Standard for Industrial Control Equipment
1449-2014(R2019)Standard for Surge Protective Devices
1998-2013Standard for Software in Programmable
Components
- G. Department of Veterans Affairs (VA)
2018VHA Boiler Plant Safety Devices Testing Manual,
Fifth Edition

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Certificates of compliance with paragraph, QUALITY ASSURANCE of this section (subparagraphs 1.5.A, B, D & F). In addition, submit Past

Performance Questionnaire (form attached) for five (5) past projects of the same class (scope & complexity) as this project.

E. Submit information sufficient to verify compliance with all contract requirements as specified and shown on project drawings.

F. Automatic Boiler Control and Burner Management and Safety Interlock Systems:

1. Catalog cuts and specification sheets providing description and performance data on: Controllers, control and indicating stations, sensors and transmitters, signal conditioners, electric switches and relays, indicators and annunciators, safety interlock devices, drive units and actuators, control valves, mechanical linkage systems, compressed air filters and regulators.
2. Statement from controller manufacturer that the type and model submitted is the current generation and that the manufacturer shall support the units with parts and service for at least ten years, and that the equipment submitted meets all VA specifications.
3. Information on all the specific systems that is sufficient to allow complete troubleshooting. As a minimum, this shall include explanation of the control logic, and wiring diagrams of equipment and systems to include locations and wire numbers of all safety device test points that shall be required to complete safety device testing in accordance with VA requirements, and sequence of operation of all components of the system.
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, all safety devices shall be easily accessible for testing...

G. 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. Paper chart recorders are prohibited.

4. Flow meter primary element design, size, performance, and sizing calculation. Steam flow performance data for flow meters verifying project performance requirements.
 5. Complete wiring and piping diagrams for all equipment and systems.
 6. Wiring and piping materials.
- H. 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.
- I. Computer Workstation and Programming:
1. Catalog data with pictures, description, and performance data on all hardware.
 2. Hardware specifications.
 3. Software model number and supplier. Include complete documentation on all software with shipment.
 4. Confirmation that graphics to be provided complies with the specification.
 5. Description of computer furniture.
- J. As-built Logic and Wiring Diagrams: One set of reproducible prints and CAD disks delivered to COR prior to turning systems over to VA for operation. Supply revised drawings if changes are made during the startup and commissioning process.
- K. Fluid Flow Meters:
1. Catalog cuts and drawings with description, specifications and dimensions of meters and accessories.
 2. Design and construction of meters and accessories.
 3. Performance data including flow, pressure drop, accuracy over the metering range of the actual fluids to be metered.
 4. Pressure and temperature limitations.
 5. Manufacturer's installation instructions.
 6. Arrangement of register face and remote indicator (if provided).
- L. Pressure Gauges and Thermometers:
1. Catalog cuts showing design, construction, dimensions of gauges and accessories.
 2. Accuracy.

3. Pressure and temperature limitations of gauges and accessories.
 4. List of scale ranges to be provided.
- M. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- N. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- O. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 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, list any VA boiler plant projects completed in the past. For instance, submit experience information on systems involving parallel positioning combustion control and on variable speed forced draft fan drives, if these systems are specified. Submit in writing that all specifications were read and fully understood.
- C. If new burners are part of the contract, the burner manufacturer shall be responsible for the burner management system (flame safeguard),

including interlocks, all accessories and for coordination with other control and monitoring systems.

D. Equipment Experience Requirements: Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

E. Code Approval:

1. All burner management and combustion control systems and devices shall comply with NFPA 85, regardless of boiler type or size. Locations and arrangements of safety devices on fuel trains shall comply with diagrams included in "Annex A" in the code, as modified by the VA standard details and the VHA Boiler Plant Safety Devices Testing Manual requirements.
2. All burner management controls and interlock devices shall be UL listed and FM approved. All controllers that include burner management functions shall be UL listed and FM approved.
3. Parallel positioning combustion control systems shall comply with UL 1998.
4. Computer-based electronic equipment shall conform to the requirements of FCC Part 15, Subpart J, for Class A computing devices governing radio frequency electromagnetic interference (EMI) while continuing to operate normally.
5. All electrical wiring shall be in accordance with NFPA 70.
6. The use of wire nuts is prohibited. All wire connections must be made at terminal blocks and terminal strips.
7. The use of liquid tight or other flexible conduit systems is limited to 900 mm (3 foot) in length unless longer runs are required for door swings or other equipment access.
8. All wire runs are required to be in conduit.

F. Personnel: All work shall be done by properly trained, skilled technicians who are regularly employed and qualified in the installation, programming, start-up, calibration, and testing of the systems provided, and who shall 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.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be PDF format and AutoCAD DWG format on CD, DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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 shall be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
 - 1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures

followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

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 or programmable logic controllers (PLC).
 2. Controllers shall be manufactured separate from and shall be separate assemblies, in a separate electrical cabinet from the Burner Management (Flame Safeguard System).
 3. Control functions:
 - a. Control of burner firing rates to maintain steam header pressure.
 - b. Parallel-positioning combustion control (air/fuel ratio, excess air) with flue gas oxygen trim.
 - c. Flue gas recirculation (FGR).
 - d. Boiler outlet draft.
 - e. Boiler water level, 1-element system.
 4. Control features:
 - a. Operator interface on controller faceplates and touch screens and computer workstation. Operator interface shall include manual/automatic selection, manual loading, and displays that show set point, process variable, and signal to actuator, process status and controller status. Touch screens have additional display requirements; refer to the following paragraph.
 - b. Provide separate dedicated controllers/panels for each boiler, for the master steam pressure control, and the existing surge tank and the existing deaerator. Fuel/air control loops, including FGR and oxygen trim may be incorporated into one

station for each boiler. Boiler/economizer outlet draft and boiler water level control shall have separate stations for each item on each boiler. All control items for one boiler may be shown on one touchscreen for that boiler. Each boiler shall have its own touch screen located in the panel for that boiler.

- c. VA Boiler Plants PROHIBIT any boiler to be automatically or remotely started and lead lag control systems are prohibited within the VA boiler plants, regardless of the size or type of boiler. The boiler shall be started by an operator standing at the boiler.
 - d. Variable frequency drives on forced draft fan motors.
5. Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES for burner management controls.
- B. Controllers: Multiple-loop programmable microprocessor or programmable logic (PLC) proportional-integral-differential (PID) solid state electronic controllers shall control all functions except burner management.
1. Accuracy: 0.1 percent analog inputs and outputs.
 2. Resolution: 16-bit input and output.
 3. Environment: 0 to 50 degrees C (32 to 122 degrees F), 15 percent to 95 percent RH, non-condensing.
 4. As a minimum, each controller shall have capability for four analog and four digital inputs, two analog and four digital outputs, and two PID loops.
 5. Memory retention for twelve months minimum for power failure or for storage as spare parts.
 6. Displays shall be a combination of English language, color graphics, and digital with 0.5 percent resolution, visible from wide angle.
 7. Bumpless manual/automatic transfer.
 8. High and low alarms for all inputs.
 9. Programming: Controllers shall have capability for quick (5 to 10 minutes) reloading of memory by operating personnel upon memory loss. Provide all software and hardware necessary to allow field downloading of configuration memory to the microprocessors.

10. Password Protection: Provide levels of password protection for all safety related options and parameters including all commissioning programming. Provide all passwords to COR.
 11. In the event of a controller fault, the controller shall have a dedicated relay output that results in the shutdown of the boiler and provides an alarm to a panel-mounted light and audible alarm. Failure of control system for one boiler shall not affect automatic and manual operation of other boilers.
 12. Controllers and software that operate variable frequency drives shall be manufactured and tested in accordance with UL 508.
 13. Controllers shall provide serial RS232/RS485 Modbus communication or ethernet IP with computer workstation running latest Microsoft Windows based operating system. This includes data gathering and processing, report generation, monitoring, annunciation and control. Refer to paragraph, COMPUTER WORK STATION AND PROGRAMMING. It shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation.
 14. All controllers, including those assigned to data processing, shall be same model and series.
 15. Controllers shall be the current generation product that shall be supported by the manufacturer, with parts and service, for a minimum of ten years from time of installation.
 16. All controllers shall be mounted within specified control panels.
 17. Examples of acceptable controllers: Cleaver Brooks "Hawk 4000"; Hays-Cleveland "AC Station"; MicroMod "Mod 30 ML"; Toshiba "LC500"; and Fireye Nexus "PPC 4000". All controllers with integrated flame safeguard are prohibited.
- 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 shall not affect other boilers.
- D. Touch Screen Operator Terminals:
1. Provide one touch screen control station and display for each boiler mounted on the boiler control panel. Touch screen shall be in complete communication with all controllers associated with the

boiler and with the burner management system. Provide alternate control station to replace touch screen control functions if touch screen fails.

2. Control Station and Display Requirements:

- a. Local operation and programming of controllers, graphic display of information, alarm message display, historical and real-time trending, remote controller tuning, x/y plots of fuel air curve data for intuitive commissioning of controllers, Ethernet connectivity and standard Internet browser remote communication. Network to boiler control and burner management systems.
- b. Selection of automatic or manual control of firing rate. Local manual control to increase and decrease the firing rate.
- c. Indicate burner management control status and diagnostics in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off, all diagnostic information available from burner management system, continuous indication of flame signal.
- d. Real time display of all connected process parameters including control output, set point, process variable, all data gathering and processing from all controllers associated with the boiler.
- e. Display of all control system alarm messages and faults. History of alarms and faults and recommendations for troubleshooting.
- f. Complete display and facilities to allow programming all controllers associated with the boiler or the master control. Burner management is excluded from this requirement.
- g. Provide alternate means of automatic and manual operation of boiler firing rates and burner management status if touch-screen fails.
- h. Provide continuous display of critical operating parameters. At a minimum, the following points shall be displayed. Review and coordinate any additional required critical points with the COR.
 - 1) Steam Pressure
 - 2) Water Level
 - 3) Draft Pressure
 - 4) Firing Rate

3. Touch Screen System Hardware and Software:

- a. 265 mm (10.4 inch) panel-mounted display, TFT with 256 colors, 640 x 480 pixel LCD resolution. Locate to allow easy viewing and access from operating floor.
 - b. Aluminum case allowing entire enclosure to be rated NEMA 4X.
 - c. Communication with Supervisory Control and Data Acquisition (SCADA) program on computer work station.
 - d. Multiple RS485 Modbus communication interfaces or Ethernet IP.
 - e. Field-replaceable backlight, real-time clock, battery-backed clock time stamps critical data, 8 MB on-board flash application memory, 512 MB memory-card, application expanded memory-card for historical, alarm and event storage, resistive analog touch screen with free formable to fit target shape.
 - f. Operation interaction shall be touch-based allowing easy selection of screens, manual/automatic status changes, start/stop functions, set point changes, output changes and PID tuning parameters without any special programming skills. Screen selection shall also be available through tactile feedback function keys.
 - g. Show facsimiles of each controller and clearly labeled English language and engineering unit display of the control parameters.
 - h. Graphic X/Y curve data plotting capability. When used in conjunction with fuel/air ratio control, provide automated fuel/air ratio curve and oxygen trim set point curve adjustment for rapid, error free burner tune-up. Only a single operator action shall be required to store commissioning data into multiple characterizer curves for a particular load point.
 - i. Configuration software Microsoft Windows based. Provide all necessary software to allow field modification or expansion of the system including graphics drawing programs and data base builders. Systems based on "run time only" programs are not acceptable.
- E. Drive Units and Actuators for Dampers, Fuel Flow Control Valves, Feedwater Flow Control Valves:
1. Electric drive units are required.

2. Electric drive units shall have continuous modulating duty cycle without any duty cycle or thermal motor limitations. Shall start instantaneously at full rated torque, stop instantaneously without coast or overshoot. Shall smoothly operate all connected devices without overload. Provide 100 percent duty cycle maintenance free motors that never overheat or burnout under stalled conditions. Gearing shall eliminate backlash. Movement shall be constant speed and shall be coordinated with the controlled process so that performance parameters remain within specified limits.
 3. Additional Requirements for Electric Drive Units on Parallel-Positioning Combustion Control Systems:
 - a. Drive units shall have precise positioning and repeatability to provide air-fuel positioning ratios with a maximum hysteresis of 2 percent.
 - 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 prohibited to perform this function within the VA. Belt-type drive units are prohibited.
 - 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. Plastic gears of any kind are prohibited.
 4. Boiler outlet damper drive units may be different model than drive units for fuel valves and forced draft damper. Drive units shall be capable of 136 Nm (100 ft-lb.) torque minimum. Less powerful drive units may be utilized if certified as adequate by the burner manufacturer.
- F. Variable Frequency Drives (VFD) for Forced Draft Fans:
1. Refer to Section 26 29 11, MOTOR CONTROLLERS, for electrical requirements. In addition, there shall be a VFD mounted operator interface unit that allows configuration of drive parameters and displays diagnostic information for troubleshooting. The minimum speed is limited to 40 Hz.

2. Provide feedback system including motor speed and direction of rotation to combustion controller. Feedback transmitter must have no-drift guarantee. Feedback system shall not be affected by position of HOA switch on motor control system.
 3. Provide noise filters.
 4. The VFD shall automatically limit the rate of fan speed increase to that which shall prevent an over-current trip in the event of a "step" speed increase of 0 to 100 percent.
 5. Provide constant speed feature and operator-selectable air/fuel program in the controller for constant speed operation maintaining specified air/fuel ratios at all firing rates or positions (excess air).
 6. Forced draft fan damper operation is required in conjunction with operation of the VFD at the lower firing rates.
 7. Provide a means of proving fan RPM to control set point at any firing rate. Deviation from set point RPM or greater than 10 percent shall cause a safety shutdown of the boiler. As an option the contractor may install a fully metered system where air flow is proven at all firing rates and a shutdown shall occur if the airflow varies by more than 10 percent.
- G. Transmitters: See paragraphs, PRESSURE SENSORS AND TRANSMITTERS and TEMPERATURE SENSORS AND TRANSMITTERS.
- H. Final Control Elements:
1. Fuel flow control valves, forced draft fan dampers, FGR dampers, variable frequency forced draft fan drives (VFD), feedwater control valves: Refer to Section 23 52 39, FIRE-TUBE BOILERS.
 2. Dampers in stacks and breechings: Refer to Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
- I. Uninterrupted Power Supplies:
1. Provide separate complete protected power conditioners for each boiler control and for master control. Power supply shall protect all computers, controls, instruments and accessories from damage due to ground leakage, spikes, sags, surges, transients and overloads in the incoming power supply.
 2. Line interactive, UL 1449 rated, interactive digital display. Automatic internal bypass. Smooth sine wave output.

3. Suitable for ambient temperature of 43 degrees C (110 degrees F) in boiler room panel.
4. Hot swappable batteries.
5. Audible and visual alarms to signal failure of power supply.
6. This UPS system can be deleted from the project if controls furnished have integral protection from power supply irregularities listed above, and if software can be immediately reloaded by plant personnel.

J. Spare Parts and Tools:

1. Master control steam pressure transmitter: One complete unit, calibrated for the service.
2. Hardware and software sufficient for downloading and uploading all programming configurations with all the controllers.
3. Electric power drive unit: One of each size and type used

K. Detailed Control Functions:

1. Control of Burner Firing Rates to Maintain Steam Header Pressure:
 - a. Automatic modulation of burner firing rates on all boilers to maintain set pressure of main steam-header. Master controller receives signal from header pressure transmitter, processes and transmits signal to submaster controller for each boiler/burner. Submaster controls fuel flow and combustion air flow.
 - b. Set Points and Performance: Accuracy plus or minus two percent of the set pressure when steam load changes do not exceed 20 percent of the maximum continuous rating of the largest boiler in service in a 60 second period. System oscillations shall be minimal. Set point 110 psig. Second set point 100 psig). Individual set point adjustment range: +/- 138 kPa (20 psig).
 - c. Control Stations: Individual control stations for master and submaster controllers. Locate control stations on main instrumentation panel or on associated boiler. Master controller shall have capability for two set points with easy selection.
 - d. Low fire hold capability and user definable optimum ignition position.
 - e. Interface with burner management system for automatic positioning of forced draft fan damper, forced draft fan speed and fuel flow

control valves during pre-purge, ignition, shutdown and post-purge.

- f. Interlocks to prove proper positions of forced draft fan damper, forced draft fan speed, boiler/economizer outlet damper, and fuel flow control valves for ignition and running cycles. Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
 - g. The steam header pressure transmitter(s) shall be dedicated to header pressure control. Suppressed range transmitter(s), each with range +/- 20 percent of required set point. If two set points are required that are more than 138 kPa (20 psig) apart, provide two transmitters. Locate transmitters adjacent to main steam-header. Refer to Paragraph, PRESSURE SENSORS AND TRANSMITTERS.
2. Parallel-Positioning Combustion Control (Air/Fuel Ratio, Excess Air):
- a. Boiler/burner submaster controller provides firing rate signals to separate drive units (actuators) for forced draft fan dampers and for each of the fuel flow control valves and to the variable frequency drive (VFD) of the forced draft fan. Air/fuel ratio maintained by firmware and software programming of the submaster controller. Software shall be factory-programmed by the controller manufacturer only, for the specific application. Only tuning and scaling shall be performed in the field. Any and all other field adjustments are prohibited.
 - 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 shutdown if deviation exceeds programmed limits or if there is a controller failure. Cross-limiting and deviation limiting shall be tested and proven. If at any time it is found this was not preprogrammed at the factory and UL tested and listed the controller shall be replaced at no additional cost or time to the Government. Only tuning and scaling shall be

performed in the field. Any and all other field adjustments are prohibited.

- 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 prohibit 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 shutdown the boiler or maintain safe excess air levels at all times, within parameters that limit the carbon monoxide emissions to specified limits.
 - f. From low fire to high fire the air/fuel ratio (excess air) shall be programmed over at least ten evenly spaced increments of fuel input.
 - g. Control positions and display indications shall be linear in relation to firing rate. For example, 20 percent control position shall be 20 percent firing rate (20 percent 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 - New Burners: Refer to the boiler and burner specification.
3. Automatic Flue Gas Oxygen Trim System:
- a. Boiler/burner submaster air/fuel controller shall utilize signal from flue gas oxygen analyzer and vary the combustion air flow to

maintain the specified air/fuel ratio (excess air) at all firing rates 20 percent of maximum firing rate and greater.

- b. Operation and Performance:
 - 1) Separate characterized set point curves for each fuel, minimum ten points per fuel. A single curve with biasing for the other fuel is not acceptable. Automatic changeover 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 ppm at any time.
 - 3) At firing rates below 20 percent of maximum steam flow, trim shall automatically return to null position (no trim).
 - 4) Variable gain to decrease output sensitivity at low loads.
 - 5) Adjustable high and low trim limiting. Excessive high or low trim correction, low excess air, or oxygen analyzer failure shall actuate audible and visual alarm on the boiler submaster air/fuel ratio controller. Analyzer failure shall cause system to go to null position.
 - 6) Manual trim output shall revert to null setting when system is placed in automatic control.
 - c. During burner start-up and adjustment of air/fuel ratios (excess air) by service technician, trim shall be on manual control at null position.
 - d. Refer to paragraph, FLUE GAS OXYGEN ANALYZERS.
4. Flue Gas Recirculation (FGR) Control:
- a. Automatic operation of FGR damper to control NO_x emissions to required limits and to provide purging of combustibles from the FGR ducts during the pre-purge cycle.
 - b. Automatically disable FGR during burner start-up cycle due to potential for flame instability. Automatically enable the FGR after the boiler flue gas outlet temperature reaches a minimum of 149 degrees C (300 degrees F).
 - c. Interface with burner management system with interlocks to prove FGR dampers in proper position for pre-purge prior to ignition. Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.

5. Boiler Outlet Draft Control:
 - a. Automatically modulate position of boiler or economizer outlet damper to maintain constant negative pressure (draft) at the flue gas outlet of the boiler. Utilize feed forward signal from the boiler/burner submaster air/fuel controller to enhance control response. Position damper open and closed during boiler start-up and shut-down cycles.
 - b. Maintain draft at negative 25 Pa (0.1 inches WG) plus or minus 10 Pa (0.05 inches WG). Provide local gauge with remote indication at operator interface.
 - c. Panel-mounted automatic controller, with manual/automatic feature and set point adjustment, for each boiler. Locate on main instrumentation panel unless otherwise shown.
 - d. Draft sensor, transmitter, and outlet damper actuator for each boiler. Refer to paragraph, PRESSURE SENSORS AND TRANSMITTERS.
 - e. Automatically position damper as required for pre-purge, burner ignition and shutdown. Provide damper position switch interlocked with burner management system. Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.
6. Boiler Water Level Control:
 - a. Automatically modulate the position of feedwater control valve on each boiler to maintain the water level in the boiler within plus or minus 50 mm (2 inches) of set point with instantaneous load swings of 20 percent of boiler capacity. Adjustable set point.
 - b. Type of System:
 - 1) Single Element System: Utilize signal from water level sensor on boiler.
 - c. Boiler Water Level Sensors:
 - 1) Water Level Sensing and Safety Control Systems: Provide on fire tube boilers. Refer to Section 23 52 39, FIRE-TUBE BOILERS.
 - 2) Probe-Type Capacitance Systems: Optional control for fire tube and water tube boilers. Dual probes mounted in water column controlled by microprocessor system. Provisions to compensate for shrink and swell of water level due to load changes. Self-

checking function comparing the signals from each probe and causing burner shutdown if water level movement is not detected.

- d. Steam Flow Sensors: Refer to paragraph, FLOW METERS.
 - e. Feedwater Pressure Sensors: Refer to paragraph, PRESSURE SENSORS AND TRANSMITTERS.
 - f. Controller: Controllers shall include: manual/auto control station and indicators showing signal level to actuator, set point and actual water level, steam flow rates and totals and boiler feedwater flow rates and totals if flow meters are included. Locate on main instrumentation panel unless otherwise shown. For controller requirements for fire tube boilers, refer to Section 23 52 39, FIRE-TUBE BOILERS.
 - g. Set point position as recommended by boiler manufacturer.
7. Boiler and Economizer Efficiency Calculation and Display: If not provided on the computer work station, provide continuous automatic calculations and indication of heat-loss combustion efficiency based on flue gas outlet temperature of economizer (or boiler if economizer is not provided), flue gas oxygen, and type of fuel in use. Base calculation method on ASME Performance Test Code, HEAT LOSS EFFICIENCY form, with no consideration for boiler radiation and unaccounted losses.

2.2 BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES

- A. Complete automatic safety control and monitoring system for burner ignition sequencing, operating cycle, and shut-down sequencing. System shall include microprocessor programmer, self-checking ultraviolet (UV) flame scanner and amplifier, burner cycle display, first-out diagnostic annunciation display, burner safety shutdown interlocks, communication with monitoring systems, and accessories. Mount controllers, control switches and displays in and on individual boiler control panels. Refer to paragraph, BOILER/BURNER CONTROL PANELS. All interlock devices shall be designed to permit periodic operational testing, including set points and trip points, without changing set points or programming, and in accordance with the VHA Boiler Plant Safety Devices Testing Manual.

1. Controller shall be manufactured separately from the Burner Control System controller.
 2. Controller shall be a separate and individual assembly from any other controller.
 3. Controller shall have its own mounting and wiring base to permit the controller to be replaced without disturbing any wiring or other components.
- B. Code Compliance: Conform to NFPA 85. All components UL listed, FM approved.
- C. Operate on 102 to 132 volts; 60 Hertz ac. Operating ambient temperature range 0 to 52 degrees C (32 to 125 degrees F).
- D. Flame Scanners: Provide self-checking ultraviolet (UV) scanners. Self-checking UV scanners shall have minimum checking frequency six times per minute. Position scanners so that they do not view the ignition spark. Scanner sight tubes must be non-reflective to avoid the scanner detecting the reflection of the ignition spark. UV non-self-checking scanners are prohibited because they can fail in an unsafe mode on continuously operated burners.
- E. Control Features:
1. Automatic recycling on high steam pressure only.
 2. Interrupted ignition.
 3. Electronically prevent UV scanner sensing ignition spark. Methods include early spark termination or by phasing the firing of the ignition spark off cycle from the scanner activation.
 4. Flame failure response time four seconds maximum.
 5. Ten seconds trial for ignition except 15 seconds permitted on heavy oil fuel.
 6. Pre-purge timing set for 4 air changes on fire tube boilers and 8 air changes on water tube boilers per NFPA 85. The exact timing must be determined by the boiler manufacturer. For example, typical pre-purge timing with wide open forced draft damper and forced draft fan at full speed has been 30 seconds for packaged fire tube boilers and 2 minutes for packaged water tube boilers. Once purge time has been determined and set it becomes burnt into the program and may not be changed.

- F. Provide components that can be easily removed from the panel without disturbing wiring.
- G. Memory storage and self-diagnostics of at least six most recent causes of burner shutdown, which can be accessed by operating and service personnel. Diagnostics shall include all individual interlocks.
- H. Provide Modbus RS232/RS485 and modem or Ethernet IP interface to allow remote access to detailed boiler plant operating data and memory. Provide interface with SCADA software on computer workstation to allow access to burner management memory and to current operating information. In addition, provide a BACnet (read only) interface to the central VAMC DDC control system.
- I. Burner cycle indication on face of panel: Separate display or integral to the touch screen is acceptable. Show instantaneous status of startup, run and shutdown program. Provide indicator for control power on, ignition, main fuel valve open, and flame failure.
- J. Reset button on face of panel. Separate display from the touch screen.
- K. Annunciator Display and Alarm:
 - 1. Separate display or integral to the touch screen is acceptable.
 - 2. Locate display on outside face of panel between 1200 mm and 1500 mm (4 feet and 5 feet) above the floor.
 - 3. English language read-out with individual identification of specific interlocks. Where two or more interlocks serve the same function, individual display of each interlock is not required.
 - 4. Indicate burner status in English messages: control on, pre-purge, trial for ignition, igniter flame signal, main flame signal, post purge, burner off.
 - 5. Continuously indicate flame signal strength.
 - 6. Provide first-out annunciation, including English language message, and audible alarm (horn) for each of the following interlocks:
 - a. Flame failure.
 - b. Purge airflow low.
 - c. Combustion air low.
 - d. False combustion air (switch activated with combustion air flow).
 - e. High main gas fuel pressure.
 - f. Low main gas fuel pressure.
 - g. Low igniter (pilot) gas pressure.

- h. Fuel safety shut-off valves not closed prior to ignition cycle.
 - i. Low fire position not attained prior to ignition cycle.
 - j. High steam pressure.
 - k. Low water cutoff.
 - l. FGR improper damper position.
 - m. Low flue gas oxygen.
 - n. High furnace pressure.
 - o. Building combustion air intake louver closed or make-up air ventilation system not operating.
7. Audible alarm (horn): Sounds upon all burner shutdowns except automatic recycle shutdowns on steam pressure. Provide silencing control, which automatically resets when burner control is reset.
- L. Pre-Purge Timing: Integral with the programmer. Non-adjustable after initially set to suit boiler pre-purge requirements.
- M. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- N. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- O. Safety shutdown and manual reset required for, but not limited to:
- 1. Flame signal detected prior to ignition cycle.
 - 2. Pre-ignition interlock open during pre-purge.
 - 3. High fire purge interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to high fire.
 - 4. Low fire interlock fails to close within ten minutes or less after firing rate drive unit is commanded to drive to low fire.
 - 5. Igniter (pilot) or main burner fails to ignite.
 - 6. Malfunction of flame detector.
 - 7. Malfunction of programmer.
 - 8. Malfunction of flame signal amplifier.
 - 9. Combustion air proving switch actuated prior to start-up of forced draft fan.
 - 10. Lock-out interlock open during pre-purge (after 15 seconds), ignition or run period.
 - 11. Interlock open.
 - 12. Flame failure.

13. Building combustion air intake louvers closed or make up air ventilation system not operating.

P. Burner Safety Shutdown Interlock Devices:

1. Basic Requirements:

- a. Adjustable Set Points.
- b. Maximum Set Point Deviation: 5 percent of full scale.
- c. Minimum Repeatability: 2 percent of full scale.
- d. Minimum Set Point Accuracy: 10 percent of full scale or 20 percent of set point.
- e. Scale range shall allow set points to be within 30 to 70 percent of full scale.
- f. Safety interlock devices shall be separate from operating control elements, such as feedback devices. This is to avoid having the failure of an operating control device preventing the operation of the safety device. All safety devices shall be hardwired directly to the flame safeguard controller without passing thru any other device or control system.

2. Provisions for Testing of Interlocks:

- a. Installation of all interlock devices shall permit testing of set points and control operation without removing or disconnecting the devices and without adjusting set points of devices. Provide permanent connection points for test instruments, such as manometers and pressure gauges, on sensing piping and tubing. Where necessary, provide lockable valves to allow temporary isolation of device from the service to allow testing of the device. All test points shall be easily accessible from the floor or permanent work platform without the use of step ladders.
- b. All interlock device wiring shall start out at and end at a terminal strip in the main cabinet. No device shall be wire directly to another device in series without returning to the main cabinet's terminal strip first. All series wiring shall take place at the terminal strip. Wiring shall be done in a manner that allows for ease of access with minimal PPE as required by NFPA 70.
- c. Safety devices are prohibited to be PLC dependent or be included in any program where the input or output can be forced, or if the

- program is changed, updated, etc., could have any effect on the safety device setting or function. All safety devices shall be hard wired from the device or sensor to the flame safeguard controller directly. Wiring may pass through terminal strip(s).
- d. Provide all necessary control system passwords, wiring diagrams, and step-by-step written instructions specific to that facility to COR to facilitate all interlock testing required by the VHA Boiler Plant Safety Devices Testing Manual. The written instructions shall include terminal and wire numbers for specific test where required.
 - e. If the system installed cannot be tested in accordance with the VHA Boiler Plant Safety Devices Testing Manual the contractor shall provide a written step by step safety device test procedure(s) for the devices(s) that follow and meet the intent of the VHA Boiler Plant Safety Devices Testing Manual, submitted to VA CFM CSS and VHA OCAMES for review and approvals. The Government reserves the right to reject any procedure and require the system device be replaced at no addition cost or time to the Government.
3. Forced Draft Fan Motor Operation Interlock: Provide split ring current relays on each phase of power circuits to fan motor, required on all systems.
- a. Provide push buttons to test each leg of the fan motor leads. The push buttons shall be mounted on the face of the cabinet, momentary contacts, wired in parallel with the current relays. The current drop through the current relay when the push buttons contacts are closed shall trip the burner off at any firing rate.
 - b. For variable speed drives, provide signals to control system from VFD fault and run contacts and signals from VFD shaft speed feedback to prove proper fan speed for purging, low fire ignition, and for each burner load point. Contractor to provide test procedure for review and approval.
 - c. Fully metered systems that measure and prove actual air flow at all firing rates may be used as a substitution. The contractor shall provide test procedures to prove the burner shuts down if

proper air flow is not maintained or achieved. The procedures must be reviewed and approved by VA CFM CSS and VHA OCAMES.

- d. Any disconnects or other power shut-off devices between the location of the interlock devices and the motor shall also shutdown the power supply to the burner management control system.
4. Forced Draft Fan Damper, Boiler or Economizer Flue Gas Outlet Damper Pre-Purge Position Interlock: Prove dampers wide open for pre-purge. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage. Parallel positioning systems may have the interlock switches in the drive units. The switches are dedicated for the flame safeguard system and perform no other function or purpose and are make or break switches.
5. FGR Dampers Position Interlock: Prove dampers positioned as required by burner manufacturer for pre-purge and firing. Actuate sealed snap-action switches by levers attached directly to dampers or to damper linkages, which are pinned to prevent slippage.
6. Pre-Purge Airflow Interlock:
 - a. Sense differential pressure between two points in combustion air system where the differential pressure at high fire is significant, such as several inches water column. There must be no intervening dampers. This is typically between the wind-box and boiler outlet.
 - b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
 - c. UL listed, FM approved.
 - d. Provide air pressure sensing connections for test manometer so that air flow switch settings can be verified.
 - e. Trip point shall prove at least 80 percent of maximum airflow.
7. Combustion Air Proving Interlock:
 - a. Sense differential air pressure across the forced draft fan with no intervening dampers.

- b. Diaphragm-actuated snap-action switch designed for maximum system pressure, adjustable set point, graduated set point indicating scales.
 - c. UL listed, FM approved. Provide switch designed for "false combustion air" feature on start-up interlock.
 - d. Provide air pressure sensing connections for test manometer so that switch settings can be verified. Demonstrate that trip point is within 10 percent of minimum differential pressure over the firing range of the burner.
8. High and Low Main Burner Fuel (Gas) And Low Igniter (Pilot) Gas Pressure Interlocks:
- a. Approvals: UL listed, FM approved assembly.
 - b. Solid-state sensor, automatic reset. Provide graduated set point indicator, switch position indicator, adjustable set point coordinated with burner requirements either on the switch or as a part of the controller.
 - c. Gas pressure switch ratings: Sustained pressure capability shall exceed two times lock-up of nearest upstream regulator.
 - d. Oil pressure switch ratings: Sustained pressure capability shall exceed set pressure, plus accumulation, of oil pump safety relief valve. On heated oil system, sustained temperature capability shall exceed maximum operating temperature.
 - e. Low gas pressure switches shall include integral impulse dampener to reduce the effects of pressure dips during start-up. Use of external dampeners or snubbers is prohibited.
 - f. Switch Locations: Must be located where pressure is constant, as controlled by pressure regulator (if provided) on fuel train. Must be upstream of modulating fuel flow control valves.
 - g. Set points shall be within 20 percent of the normal operating pressure.
 - h. High pressure switches shall be piped to the service with lockable isolation valve and valved test connection so that switch can be set and tested using compressed air.
9. Main Fuel (Gas/propane) Automatic Safety Shut-Off Valves Proof-Of-Closure (Over Travel) Interlocks. Provide on all automatic safety shut off valves to prove closure prior to igniter (pilot) ignition.

Provide manually-actuated test circuits through the proof-of-closure switches that shall demonstrate that the switches close and open properly and that the circuit is connected to the burner management system.

10. Low Fire Position of Fuel Flow Control Valves Interlocks: Sealed snap-acting switches. Actuate switches by levers attached directly to fuel valves. As an option, the switch lever may be pinned to the jackshaft to which the fuel valve proportioning cams are also pinned or provide UL listed and FM approved position sensor (internal snap acting switches within the actuator a feedback signal may not act as any part of this safety device.) on the motor which positions the jackshaft to which all the operating levers are pinned.
11. High Boiler Steam Pressure Limit and Interlock: Operating limit switch allowing burner recycling and safety shutdown interlock switch. Refer to paragraph, BOILER TRIM, in Section 23 52 39, FIRE-TUBE BOILERS.
12. Low Boiler Water Level Interlocks: Primary and auxiliary low water burner shutdown interlocks. Refer to paragraph, BOILER TRIM, in Section 23 52 39, FIRE-TUBE BOILERS. Operation of auxiliary low water cutoff shall interrupt the power supply to the burner management control system. The devices shall be of two different types, i.e. flow switch and pressure differential transducer. Series wiring must not take place at the devices; it shall take place at the control panel terminal strip so that it can be wired for independent confirmation of failed device.
13. Low Flue Gas Oxygen Alarm and Interlock: Signals from flue gas oxygen analyzer providing low oxygen alarm and low oxygen burner shutdown. Refer to paragraph, FLUE GAS OXYGEN ANALYZERS.
14. High Furnace Pressure Interlock:
 - a. Sense static pressure in furnace.
 - b. Diaphragm-actuated snap-action switch, adjustable set point, set point indicating scale, designed for maximum system pressure.
 - c. UL listed, FM approved.
 - d. Connect to the service with a lockable isolation valve and valved test connection to allow the switch to be set and tested with pressurized air source.

15. Building Combustion Air Intake Interlock: Provide devices to prove outside air building wall louvers are open or H&V unit is in operation.

Q. Automatic Programming Sequence:

1. After personnel select the fuel to be burned and operate the burner start switch, the control system shall automatically perform the following operations:
2. Prove proper operation of all interlocks except purging interlocks or prevent further progress.
3. Open all air dampers fully. This includes all dampers in the boiler outlet breeching and stack system.
4. Position FGR damper (if provided) as required by burner manufacturer to purge flue gas from recirculation duct.
5. Prove 80 percent of maximum air flow through the boiler and prove all air dampers open wide and FGR damper (if provided) in proper position.
6. Pre-purge eight air changes for water tube boilers and four air changes for fire tube boilers.
7. Return forced draft fan dampers and fuel flow control valves to low fire position.
8. Retain outlet damper wide open. If outlet draft damper modulating control system is provided and excessive draft due to wide-open damper is incompatible with the burner, automatically position the outlet damper to an acceptable position for burner ignition.
9. Prove low fire start position.
10. Sensing of flame prior to this shall cause shutdown.
11. Energize igniter and open igniter fuel automatic safety shut-off valves. Prove igniter flame in ten seconds or provide shutdown.
12. On systems with ultraviolet flame scanners, terminate ignition spark five seconds before main fuel valves open.
13. Open main fuel safety shut-off valves for fuel selected. Close igniter fuel valves within ten seconds after main fuel valves open (15 seconds on heated oil).
14. Prove main flame or provide shutdown.
15. Place FGR damper (if provided) in modulating or in fixed position as required by design of burner furnished.

16. If provided, release boiler/economizer outlet draft control damper to modulation.
17. Release burner from low fire position to automatic or manual firing rate control.
18. Provide 15 second post purge at end of burner firing cycle.
19. Close all dampers upon completion of post purge.

R. Spare Parts:

1. One flame control programmer chassis complete.
2. One flame control amplifier complete.
3. One flame scanner complete with connecting leads.
4. Twelve lamps for each type of replaceable lamp.
5. Two of each type of relay and timer.

2.3 MAIN INSTRUMENTATION AND CONTROL PANEL

- A. Type: One free-standing factory-assembled steel enclosure with control stations, control switches, instruments and indicators on panel front and controllers, relays and other components mounted on interior sub-bases. NEMA ICS 6, Type 4 rating. Refer to drawings for arrangement and overall dimensions. Main control system shall output via BACnet to existing Trane DDC system for data collection and monitoring.
- B. Panel Construction:
1. Minimum 3.5 mm (0.14 inch) thick steel sheet with steel angle or bar reinforcement. Provide vertical reinforcement from top to bottom of panel between each large instrument opening. Provide horizontal reinforcement above and below each large instrument opening.
 2. Provide sufficient reinforcement to prevent any warping or displacement due to weight of equipment mounted on and within panel.
 3. All corners and edges shall be smooth.
 4. Rear Access Doors: Sufficient quantity to cover full height and width of panel, three-point latches with key-type locks, three hinges per door, or piano-type hinges.
 5. Finish:
 - a. Exterior: Undercoat of rust-resistant primer, finish coats of textured spatter paint, dark gray.
 - b. Interior: Undercoat of rust-resistant primer, finish coats of enamel, light gray or white.
 6. Provide duplex 120-volt GFI receptacle inside the panel.

7. Provide fan-type or panel mounted air-conditioning units for ventilation as necessary to protect equipment from overheating. The internal panel temperature shall be maintained at 32 degrees C (90 degrees F) or below. Assume boiler room temperature of 38 degrees C (100 degrees F). Compressed air coolers are prohibited.
- C. Master Steam Pressure Control Station: Refer to paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD). Unit shall be flush mounted on panel front.
- D. Boiler/Burner Submaster Control Stations: Refer to paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD). Units shall be flush mounted on panel front.
- E. Touch Screens: Refer to paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD).
- F. Pressure Gauges: Flush mounted, ½ percent accuracy, 150 mm (6 inch) dial diameter, micrometer adjustable pointer, solid front, blow-out disk in rear, back connected, and of indicated range. Provide gauge cock within panel for each gauge. Provide gauges for steam header pressure, boiler feed header pressure for each boiler, fuel header pressures.
- G. Push Button Stations and Indication Lights for Pump Control: Refer to Section 26 29 11, MOTOR CONTROLLERS. Lights shall be oil-tight, standard industrial construction, 120 volts, utilizing lamps which are readily available. Lenses shall be red and green colored, held in place by threaded ring. Push button stations shall be flush mounting, oil tight, momentary contact. Provide non-latching lamp test control on main panel.
- H. Annunciator:
 1. Provide system for monitoring alarm functions listed below.
Annunciator shall include alarm lights, alarm bell, integral test and acknowledge push buttons. Include Modbus communications for use with computer workstation.
 2. Type: Multiple rectangular back-lighted windows on which alarm functions are engraved; separate window for each function. Provide test and acknowledge controls. All alarm lights shall operate independent of the PLC or if PLC fails all indicator lights shall still function.

3. Construction:
 - a. Window Size: 45 x 75 mm (1-3/4 x 3 inches) minimum.
 - b. Lamps: Minimum of two per window.
 - c. Operating Mechanisms: Solid state electronic, accessible for repair without removing entire annunciator from panel. Provide all equipment for complete system.
 - d. Bell: 150 mm (6 inch) diameter, surface mounted.
4. Operating Sequence:
 - a. Condition Normal: Bell and light off.
 - b. Condition Abnormal: Bell on; light flashing.
 - c. Acknowledge: Bell off; light on steady.
 - d. Condition Returns to Normal: Bell and light off.
 - e. Test: Bell on; light flashing.
5. Alarm Sensing Systems: Provide complete wiring, controls, conduits, and accessories.
 - a. Condensate Storage Tank and Feedwater Deaerator Storage Tank High and Low Water Level Alarms (4 functions): Actuated by sensors mounted on storage tanks. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
 - b. High and Low Steam Header Pressure (2 functions): Actuated by adjustable automatic reset UL listed pressure switches. Range of adjustable set point 276 to 1241 kPa (40 to 180 psig), 34 kPa (5 psig) maximum differential. Provide steam siphon loops, shut-off valves.
 - c. Emergency Gas Valve Closed: Actuated by switch provided with valve assembly.
 - d. Oil Tanks - High and Low Level (2 functions per tank): Separate high and low-level indications for each tank. Actuated by oil tank level monitor system. Refer to Section 23 10 00, FACILITY FUEL SYSTEMS.
 - e. Low Excess Air - Boiler (1 function per boiler): Actuated by flue gas oxygen analyzers. Refer to paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMENT (FLAME SAFEGUARD).
 - f. High Natural Gas Header Pressure: Actuated by adjustable, automatic reset, pressure switch connected to gas header. Switch

shall be UL listed for natural gas service. Provide shut-off cock between gas header and switch.

- g. LP Igniter (Pilot) Gas in Use - For Emergency Only: Actuated by adjustable, automatic reset, UL listed, FM approved, high pressure switch mounted on LPG header. Range of set point 6.9 to 69 kPa (1 to 10 psig), emergency rating 30 psig.
 - h. Fuel Oil Temperature - High and Low (Heated Oil Only): Actuated by temperature switches located on the fuel oil header. Automatic reset, adjustable set point and dead band, UL listed, set point range 10 to 65 degrees C (50 to 150 degrees F). UL listed, removable without draining system, set point indicator.
 - i. Low feedwater pressure (1 function per header): Actuated by pressure switches on feedwater headers.
 - j. Input/Output (I/O) Modules: Provide 20 percent (2 minimum) installed spare I/O of each type for computer data acquisition system.
- I. Emergency Fuel Safety Shut-Off Valve Control: Provide maintained contact, emergency safety shut-off push-pull control switches with mushroom heads on outside face of panel, control room, and at all personnel doorways, or routes of egress from the operating floor. The shut-off shall shutdown the main and igniter emergency safety shut-off valves from power source on the natural gas, and shutdown all other fuel sources. Valves shall remain closed and pumps remain off when switch is pulled out. Shall require a manual reset or restart.
- J. Remote Alarm Indication Station:
- 1. Provide system for monitoring alarm functions listed above under the main panel annunciator section. Annunciator shall include alarm lights, alarm bell, and horn silence push button.
 - 2. Type: Device shall include an indication light, alarm horn and an alarm horn silence.
 - 3. Operating Sequence:

Upon an alarm contact closure, the indicator will light, and the horn will sound. The horn can be silenced through the alarm silence switch, while the visual indication will continue to be lighted until the alarm condition has been corrected.

- K. Clock: Microprocessor-driven digital, 65 mm (2-1/2 inch) high wide-angle LED display, selectable 12/24 hours, enable/disable automatic daylight savings time changeover, enable/disable alternating time and date, seven-year battery-back-up memory, time base accurate to plus or minus two minutes per year.
- L. Nameplates: Provide engraved plastic laminated nameplates for all devices on front of panel. Nameplates shall have white letters on black background. Mount with screws or rivets. List equipment title and identification number, such as "BOILER FEED PUMP P-1." Do not use abbreviations.
- M. Auxiliary relays: Industrial type rated for the service, enclosed contacts.
- N. Selector switches, push buttons and control switches: Heavy duty, industrial type.
- O. Wiring and Piping Methods:
1. All devices mounted in and on panel shall be factory-wired and piped.
 2. All electrical contacts shall switch the phase conductor.
 3. Electric wiring: Conform to NFPA 70, all wiring in troughs, terminations in industrial class terminal blocks, terminals numbered for identification, 20 percent extra terminals. All wiring color coded and numbered using numbering system that identifies the destination. There shall be no exposed wiring connections exceeding 120 volts inside the panels. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS, and Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS and CABLES.
 4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.
- P. Spare Parts Required:
1. Lamps: Six of each type in panel and instruments.
 2. Touch-up paint for panel: One pint.

2.4 BOILER/BURNER CONTROL PANELS

- A. Type: Individual boiler/burner control panels with control stations, control switches, instruments and indicators on panel fronts and controllers, relays and other components mounted on interior sub-bases. Panels shall be boiler-mounted.

B. Panel Construction:

1. NEMA ICS 6, Type 4. Freestanding panels shall be minimum 3.5 mm (0.14 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 or panel mounted air-conditioning units for ventilation as necessary to protect equipment from overheating. The internal panel temperature shall be maintained at 32 degrees C (90 degrees F) or below. Assume boiler room temperature of 38 degrees C (100 degrees F). Compressed air coolers are prohibited.

C. Burner Management System with Annunciator: See paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.

D. Boiler Control Stations or Touch Screens, burner management displays and resets: See paragraph, AUTOMATIC BOILER/BURNER CONTROL SYSTEM, NOT INCLUDING BURNER MANAGEMNT (FLAME SAFEGUARD) and paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.

E. Draft Gauges: See paragraph, BOILER DRAFT GAUGES.

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 shutdown annunciator specified above may be used. Standard water level alarm display of water level control manufacturer may be used.
 3. Alarm bell: 150 mm (6 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 previous paragraph).
- 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 and numbered at both ends. Wiring in series from one safety device to the next device is prohibited at the devices. Series wiring must take place at the terminal strip in the main cabinet.
 4. Piping: Stainless steel tubing, securely mounted, terminate in fittings at top of the cabinets.

J. Panel Certification and Testing:

1. Manufacture and inspection of completed panels, including all wiring and components, shall comply with UL 508.
2. Complete cabinets shall be factory tested and certified. The panel shall be labeled as complying with UL 508. A copy of the wiring diagram shall be placed in the cabinet prior to shipment.

2.5 COMPUTER WORK STATION AND PROGRAMMING

- A. The individual boiler plant controllers and instrumentation system shall be networked with a central computer workstation to provide remote operation of the controllers, custom graphic display of information, alarm message display, report generation, historical trending and remote tuning of controllers. All control functions shall be accomplished within the individual controllers and shall be monitored by the central computer so that the integrity of the control system shall not be dependent on the status of the central computer or the interconnecting network. Burner management (flame safety control) systems shall not be controllable from the workstation but shall be monitored from the workstation for status and access to historical data. Modem and software shall provide remote communication with diagnostic and status indications.
- B. Hardware:
1. Microsoft Windows based desktop computer workstation with keyboard, mouse, two speakers, color graphic monitor, alarm printer (existing), logging printer (existing), and uninterrupted power supply. Equip with latest version Microsoft Windows operating system compatible with SCADA software furnished. The system shall be designed so that additional workstations and peripheral equipment can be added in the future. Provide all devices necessary for complete access to all features of the programs applied.
 2. Desktop Computer: Comply with requirements published by SCADA software supplier for optimum performance of software furnished. System must include hardware as recommended by Microsoft for installation of Windows Business operating system. Minimum requirements are Intel Xeon processor, 4 MB L2 cache, 2.4 GHz, 1066 FSB; 16 GB 600 MHz DDR2 SDRAM memory ECC (2 DIMMS); dual hard drives each 400 GB SATA, Nvidia QUADROFX4400 512 MB graphics, DVD+/-RW

- optical drive, integrated gigabit Ethernet, sound card, audible alarm and a battery-backed clock which counts seconds, minutes, hours, days and years. Provide two parallel ports and two serial ports, minimum.
3. Digital Flat Panel Color Monitor: TFT, 483 mm (19 inch) diagonal (nominal) screen with capability of 1600 by 1280 pixels resolution, non-interlaced, dot pitch 0.31 maximum. Minimum of True 16bit colors supported. Energy-Star compliant.
 4. Keyboard: ASCII standard, QWERTY-style, enhanced 101-key consisting of at least 32 dedicated function keys and a 12-key numeric data entry section. Keys shall have tactile feedback and be permanently and clearly labeled. In addition, a set of arrow keys shall be provided for moving from the current screen of data to "next screen". Function keys shall have custom legends for each key to allow report generation, graphic display selection, alarm silencing, and data retrieval with single keystrokes. Provide removable continuous Mylar faceplate to exclude dust and spills.
 5. Mouse: The operator interface shall minimize the use of the typewriter style keyboard through the use of a mouse and "point and click" approach to menu selection. Users shall be able to access features of the program from graphical displays through the use of the mouse.
 6. Alarm Printer: Use Existing.
 7. Logging Printer: Use Existing.
 8. Speakers: Provided by computer manufacturer.
 9. Uninterrupted Power Supply: Provide complete protected power conditioner. Line interactive, UL 1449 rated, interactive digital display. Power supply shall protect computers, controls, instruments and accessories from damage due to ground leakage, spikes, surges, sags, transients and overloads in the incoming power supply. Smooth sine wave output. Hot swappable batteries. Audible and visual alarm to signal failure of UPS.
 10. Provide a desk unit for support of microcomputer, terminals and peripherals. The desk shall have a 600 x 762 mm (24 x 30 inch) workspace in addition to space for equipment. Desk shall have at least two drawers.

C. Supervisory Control and Data Acquisition (SCADA) Software:

1. Generally available non-custom system compliant with latest version of Microsoft Windows. Shall use Windows Open Systems Architecture (WOSA), such as in its use of dialog boxes and menus. Local system with capability for future networking. All features shall be supported on the in-plant hardware specified. The software shall be a complete package requiring no additional software to configure or run the features of the program. Program shall not require hardware "dongle" keys for licensing. The program shall be completely configured to perform all required functions at the required speed and with complete accuracy.
2. Configuration shall be accomplished from the keyboard or the mouse. All configuration changes shall be capable of being made while the system is on-line (operating) without interfering with the normal functions of the program. No programming, compiling or linking shall be required to configure the system.
3. Provide complete user documentation in electronic format, including examples of how to operate the various modules of the system. Provide keyword and specific text search features.
4. On-line "help" facility, based upon Windows standard Hypertext. This shall support full text word search, add custom comments, bookmark topics, copy and pasting into another application, printing, and use of system fonts and colors.
5. Provide pre-emptive multitasking to ensure that common Windows actions are permissible and do not interfere with I/O communications, processing of data, alarming, and the integrity of the real-time and historical data.
6. Functions shall be available to support the following:
 - a. Analog and Digital Input/Output.
 - b. Analog and Digital Alarm.
 - c. Analog and Digital Register.
 - d. Boolean Logic.
 - e. Calculation: Includes add, subtract, multiply, divide, parentheses, absolute value, square root, exponentiation, logs, relational operations, change floating point values to integers.
 - f. Device Control.

- g. Event Action.
 - h. Fanout.
 - i. Multi-state Digital Input.
 - j. Program: Sequencing, monitoring, process control.
 - k. Real-time Trend.
 - l. Text.
 - m. Timer.
 - n. Totalizer.
7. Wherever possible, the device communications program shall perform error checking on messages. This will include lost response and data error. Should communications errors be detected, the software shall automatically indicate that the data is no longer valid and identify the invalid data. The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data without any user programs or other actions to implement.
 8. The system shall include a diagnostic program capable of running on-line or off-line that can monitor message rates from the communication program. The diagnostic shall display the number of new messages, retries, time-outs, and any occurrences of error.
 9. The system must support third-party objects and controls to be plugged in via OLE and Active X support.
 10. Support of accessing data to and from the process database and historical archive to another (future) database using Structured Query Language (SQL) as a standard language.
 11. Graphics Capabilities:
 - a. Color object-oriented graphic displays for monitoring and controlling the process, which show the actual configuration of the process. Real-time values from various field devices shall be displayed in a variety of user-configurable formats. Displays shall be standard MS Windows files. Graphic screens shall be based on objects and not individual pixels.
 - b. Interactive object-oriented editor or workspace that allows creation and editing of graphics using a mouse. Capability of making changes to the graphics without shutting down the system.

- c. Graphic screens that are opened in configuration mode must support tiling and cascading. Tiling must have horizontal and vertical support and no overlapping when the graphic screens are viewed.
- d. Size shall be based on logical units; not pixels and any logical unit may be used. A design at one resolution must be able to run at a different resolution. Provide full screen option and the ability to add sizing borders to any graphic screen. Provide title bar enabled/disabled option.
- e. Support 256 colors. Color changes must be selectable from editing the individual foreground, background, or edge color property for each object.
- f. Provide configurable toolboxes that the user can customize as to what tools it contains and their position in the toolboxes. Provide a method to describe the function of each tool when the cursor is positioned on a particular tool.
- g. As a minimum, support the following object drawing tools: rectangle, square, rounded rectangle/square, oval/circle, straight line, polylines, polygons, arcs, chords, pie shapes, text.
- h. Operations that may be performed on objects or groups of objects must include: select/select all, deselect/deselect all, change color, move, nudge, cut, copy, paste, clear, duplicate, group/ungroup, align, space vertically/horizontally, grid, snap-to-grid, reshape, zoom in/out, send-to-back/bring-to-front, choice of line and fill styles, flip, search and replace tag names, undo, cursor position, rotation, space objects evenly, make objects same size, layers.
- i. Provide ability to dynamically update elements in the picture. Dynamic link elements shall include: data, time, date, system information, alarm summary, pushbutton, multi-pen chart, OLE objects.
- j. Multiple-pen chart link shall include: unlimited number of pens, display run time and historical data on same chart, configurable time span, configurable trend direction, configurable zoom, scrolling grid, invert high and low limits, minimum of five line

styles for pens, minimum of three pre-built line makers and a customizable line marker.

- k. Dynamic properties for objects must include: color changes (foreground, edge, background), fill percentage (horizontal, vertical), position/animation (horizontal, vertical, rotate, scale), script language (commands on down, up, mouse click, mouse double click, mouse move, edit), fill style (solid, hollow, horizontal, vertical, diagonal, cross hatch), edge style (solid, hollow, dash, dot, dash-dot, dash-dot-dot, null, inside frame). Provide capability to assign more than one dynamic property to an object.
- l. For properties other than commands, configuration shall be by the mouse. Scripting or programming shall not be required. When building object dynamics, properties must support configuration from a dialog box, pop-up menu and user customizable dialog boxes or forms. Positioning property changes must support a method to get screen coordinates and automatically fill in the required coordinates for positioning. The user customizable dialog boxes or forms must be customizable through VBA. The system must supply the following pre-built forms: fill, rotate, position, scale, visibility, edge color, foreground color, background color, data entry, open/close picture, replace picture, open/close digital tag, toggle digital tag, acknowledge alarm.
- m. The refresh rate shall be user-definable on a per object basis with the fastest being fifty milliseconds.
- n. The animation of the graphics and objects shall be able to be linked to: Data acquired and stored by the system, data acquired and stored by a networked system, variables declared in the command language scripts, local and networked relational databases using SQL/ODBC.
- o. Provide a wild card supported filter for assigning a data source. Provide a mathematical expression builder that is accessible from the graphic workspace.
- p. Provide for easy reuse of graphic objects or groups of objects. The objects shall be intelligent Windows wizard-like objects. A

library of objects shall be included: pipes, valves (manual and automatic types), pumps, motors, tanks.

- q. The system must allow for bitmaps created by other systems to be imported into the graphics. Bitmaps must support a transparent mode and Metafiles must import as objects, not just bitmaps. As a minimum, the system must import .bmp, .msp, .jpg, wmf, pcx, ico, cur, psd, epr, and wpg.
- r. MS Word and Excel documents must be able to live within a graphic screen, running with the graphic, not as an external call. Word and Excel toolbars must be inserted as part of the graphic toolbars.
- s. Printing of graphic displays in color and black and white shall be supported via the standard MS Windows print manager in both the graphics development and runtime environments.
- t. Operator entry methods shall be a flexible MS Windows NT method. Item selection and data entry shall be done with mouse or keyboard and the selected item shall be highlighted. The following data entry methods shall be supported: numeric, slider, pushbutton, ramp value, alphanumeric.
- u. The system shall print a descriptive message with time stamp and user ID on the alarm printer or to an alarm file (as selected by user) whenever any of the following events occur: alarm, alarm acknowledgement, data entry into tag, reloading database file, saving database file, restarting the system.
- v. The scripting language used by the system must be MS Visual Basic for Applications (VBA) or equivalent with one of the software packages specified. Scripts shall allow users to automate operator tasks, and create automations solutions. The scripting language must use MS IntelliSense feature, exposing all methods and properties of graphic objects. Editing shall be with the Visual Basic Editor (VBE), which is part of VBA. Scripting language requirements include: animation of objects, automatic generation of objects, read write and create database blocks, automatically run other applications, incorporate custom security features, create custom prompts and messages, incorporate and communicate with third party and custom Active X controls, trap

bad Active X controls, write custom wizards, scripts become part of the graphic screen, the VBE must allow import and export capability, there must be a link from the graphic editor to the VBE, VBA or VBE is launched from within the system without any commands, all properties method and event of graphic object created within the graphic editor of third party Active X controls used in the graphic screen must be exposed to VBA.

12. Alarms and Message Handling:
 - a. The system shall be capable of detecting alarm conditions based on the states and values of the various sensed variables whether or not the variables causing the alarms are on display. Alarm set points shall be enterable by the user upon configuration and during run time. Alarm types shall include: high high, high, low, low low, bad input from I/O, alarm disable, off scan, deadband, change of state, open, close. Support at least three priorities for each alarm type: high, medium, low.
 - b. Message enabling and disabling must be controlled at the block level. The system must be capable of sending messages based on the following events: an operator event occurs; process database event occurs. In addition to alarms, the following types of blocks must be able to generate messages that report to any transactions to and from the hardware: digital input, digital output, digital register, analog output, analog register, text.
 - c. The system must generate applications messages that describe database-related activity or operator entry. These messages shall be logged to alarm areas. Types of messages include: operator changes a process value, loads process database, logs into the system; any recipe upload, download or save condition; send information from a VBA script to all enabled alarm destinations; send a message from the database to all alarm destinations.
 - d. The system shall provide a means for placing an alarm message in one or more of the following locations: alarm summary display, alarm printer, alarm message file on disk, alarm history window.
 - e. Alarm messages shall be independently user-configurable as to what information is provided and its sequence within the message. The following shall be available choices: time of the alarm

occurrence, name of tag causing the alarm, engineering units value, descriptor text assigned to the tag, engineering units of the tag.

- f. When a new alarm condition is detected, an alarm message shall be generated. If the alarm condition code text for the block is on the current display, then the text shall flash until the alarm is acknowledged. Alarm acknowledgement shall be performed from the keyboard or with the mouse and shall require no more than one keystroke or mouse click. The software shall include the following capabilities: alarm suspension which allows the user to specify digital tags that, when closed, cause alarms not to be generated for alarm conditions; re-alarm time which allows the system to re-generate an alarm after a user-configurable amount of time; alarm delay time which allows the user to specify a period of time for which an alarm condition must remain before an alarm is generated; close contact on alarm which allows user to specify digital tags that become closed when certain alarm conditions occur or reopened under certain conditions to allow operation of audible and visual alarms in the plant.
 - g. Provide an alarm summary display as a dynamic link within the graphics package. This must show a list of the pending alarms in the system. As new alarms are detected, entries are made to the display list. Placement of alarm information and color codes shall be configurable. Alarms can be acknowledged from the summary display either individually or for all alarms in the queue.
13. Archiving and Reporting:
- a. Provide facility for automatically collecting, storing and recalling data. Recalled data shall be made available to a trend display program, a report generation program and to user-written programs.
 - b. Store data in Windows-compatible files in compressed format. Entries containing time, name, value and status shall be made in the file whenever the real-time value exceeds the previously stored value by a user-supplied deadband limit. A deadband value of zero shall cause an entry in the file each time the real-time

value is examined. Files shall be organized according to time and shall contain values for multiple, named variables. The files can be placed on the hard disk or floppy disk. Provide a mechanism for on-line maintenance and automatic purging of files.

- c. The data to be collected by the archiving program shall be identified through an interactive, menu-based configuration. The user shall enter the tag name, collection rate, and data compression deadband value. Collection rates shall be selectable: 1 second, 2 seconds, 10 seconds, 20 seconds, 30 seconds, 1 minute, 2 minutes, 10 minutes.
- d. The operator shall be able to recall archived data from the disk to be displayed in graphic format along with real-time data. The display of archived data shall be user-configurable. It shall be possible to configure objects in graphic displays that, when selected, fetch pre-defined historical trend data from disk and display it to the operator. Attributes of pens shall be editable during run-time.
- e. The historical trend display shall be made up of the following components:
 - 1) Pen Group: Configuration shall be used to define the particular tag names to be displayed. Along with tag names, pen color, marker style and engineering units may be defined.
 - 2) Time Group: Configuration shall be used to define the time period over which the archived data is to be displayed.
 - 3) Legend Group: Configuration shall be used to define the legend parameters for a historical display. Both a primary and alternate legend may be displayed.
- f. The display shall support unlimited variables to be displayed on the same time/value axis simultaneously. For each entry in the display list, the operator shall be able to assign a given tag name and marker to a particular line color selected from palettes of unlimited colors. The operator may also enter display engineering units ranges to cause scaling of the display. Support shall be provided for multiple, different y-axis engineering units to be displayed as appropriate.

- g. The display shall have two fields of view. The top portion of the screen shall be the graphic field and shall display the values of the variables (y-axis) against time (x-axis). It shall also contain labels for the axes and graphs. The bottom portion of the screen shall be user-configurable to display information, such as node-names, tag names, and descriptors, pertaining to the tags in the trend display.
 - h. The trend object shall allow for bi-directional trending and scrolling. A movable, vertical line shall act as a time cursor on the display. The date, time and values of the trends corresponding to that time shall be displayed in the bottom portion of the screen. The grid of the trend object shall be scrollable. The trend shall be shifted forward or backward in time by clicking on the right/left buttons. New data shall be fetched from the historical file as appropriate. The ability to display historical data with current data on the same chart must be supported. A transparent option for the trend must be selectable. The user shall be able to "zoom" on any section of the trend display by "cutting" that section with the mouse. The software shall automatically re-scale both the y-axis and the time axis and shall fetch the appropriate data for the time period selected. The trend object must have a refresh rate selectable in 0.10 second increments from a minimum of 0.10 seconds to a maximum of 1800 seconds.
 - i. The trend display shall be printable to a black and white or color printer via the standard MS Windows NT print manager.
14. Event Scheduling:
- a. The system shall support a scheduler with time-based printing of reports.
 - b. The system shall allow for scheduling of the following time-based printing of reports: Hourly, shift, daily, monthly, yearly.
15. Security Management:
- a. Provide a user-based security system which, when enabled, must allow for the creation of users with certain rights and/or privileges. These rights must include the ability to run any combination or all of the applications in the data acquisition

system. The ability to allow or disallow users access to change values, such as set points and control setups, on an individual tag basis shall be supported.

- b. Groups of users, such as operators or supervisors, can be created and granted rights. All users assigned to a group obtain the rights of the group although they are tracked by the system by their individual ID. Individual members of a group may be also assigned additional rights.
- c. The system must support a tie to Windows NT security. When user-based security is enabled, an audit trail shall be generated in the system, which shall tag every operator action with a user ID.
- d. The system must support at least twenty separate security areas, assignable on a per-tag basis. Each tag can be assigned all of the available security areas, none of the available security areas, or up to three individual security areas. Only users with clearance for those security areas shall have the ability to change parameters. Security area names may be up to twenty characters in length.
- e. The following functions must be supported: enable/disable user-based security; define users, passwords and login names; define groups to which users may belong; define security paths; define user and/or group rights/privileges; define security area names; define system auto-start user.
- f. The ability to lock an operator or other user into the runtime graphics environment shall be provided. Disabling any combination of the following shall be supported, as configured by the user: starting other applications; switching to other applications that may be running; exiting from the system; restarting the computer using <Ctrl><Alt><Delete>; opening unauthorized screens; closing current screens; using the system menu; switching to the configuration environment; accessing the system tree.
- g. The system shall allow for a login timeout setting for each user account. The system shall support manual login in and logout as well as automatic login. In addition, security information must be customizable through VBA scripting.

16. Services:
- a. Training: An interactive on-line tutorial shall be provided as part of the software to teach the basic operations of the system, including graphics and tag development. The tutorial shall demonstrate the configuration operations using interactive on-screen instructions. Standard classroom courses for operators of the system that cover the configuration and use of the system shall be available.
 - b. Customer Support: Programming staff shall provide 24/7 support via telephone and email. Field service by programmer, or programmer-trained distributor, shall be available on two-day notice.
 - c. Quality Assurance: The vendor must have a formal and documented set of quality assurance procedures that are applied to the engineering design, development, and documentation of the software. The software shall have been in use by customers for at least three years.
17. Remote Operation of Controllers:
- a. Provide capability to operate controllers locally at the control and indicating stations and, except for burner management (flame safety) controls, remotely at the computer workstation. For safety, it shall be possible to defeat the remote control from the front panel of each individual controller, preventing any status changes from being initiated at the computer workstation. The controllers include: master steam pressure, boiler/burner sub-master, burner fuel/combustion air, boiler draft, burner oxygen trim, boiler feedwater level, deaerator water level, condensate storage tank water level, surge tank/transfer pump control panel, condensate receiver tank/pump control.
 - b. The operating personnel, when controllers are so enabled, shall have remote control of the following functions from the computer work station:
 - 1) Select manual/automatic mode.
 - 2) Set point (requiring use of high-level password).
 - 3) Controller output when in manual mode.

- 4) Proportional/integral/derivative tuning parameters (requiring use of high-level password).
 - 5) Controller analog output values.
 - 6) Controller discrete output values.
 - c. The monitor display shall provide a facsimile of the controller front plates with clearly labeled English language and engineering unit display of the control parameters.
 - d. No special programming skills shall be required for any routine operating sequence.
18. Graphics: As a minimum, the following pictorial "screens" shall be available for observation:
- a. Individual boilers with economizers (if provided) showing:
 - 1) Main flame proven and approximate firing rate as shown by flame size depiction.
 - 2) Steam output instantaneous flow rate (pressure compensated), lb/hr.
 - 3) Steam output flow totalization (pressure compensated), lb. This is total production starting from time, day, month and year as set by operating personnel. Calculation shall be accomplished in control or instrumentation system, not in the SCADA software.
 - 4) Steam header pressure, psig.
 - 5) Boiler flue gas outlet temperature, °F.
 - 6) Boiler flue gas oxygen percent. Set point of oxygen trim system (if trim provided).
 - 7) Boiler stack opacity (if opacity monitors are provided).
 - 8) Boiler flue gas outlet draft (if outlet draft control system is provided), inches WG.
 - 9) Economizer flue gas outlet temperature, °F.
 - 10) Economizer feedwater inlet temperature, °F.
 - 11) Boiler feedwater inlet (economizer outlet) temperature, °F.
 - 12) Signal to feedwater control valve.
 - 13) Water level in boiler plus or minus inches from normal level.
 - 14) Boiler plus economizer "Heat Loss" combustion efficiency not including radiation and unaccounted losses.

- 15) Fuel flow rate and totalization if individual boiler fuel meters are provided scfh. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
- 16) Feedwater flow rate and totalization if boiler feedwater flow meters are provided gpm; gallons. Totalization calculations shall be accomplished at the meters, not in the SCADA software.
- 17) Trends of all flow, pressure and temperature data as listed above.

b. Boiler Plant:

- 1) Feedwater deaerator storage tank water level, inches of water.
- 2) Feedwater recirculation 2 position control valve status.
- 3) Condensate storage tank water level, inches of water.
- 4) Oil tanks oil level, gallons of oil.
- 5) Pumps in operation.
- 6) Chemical feeders in operation.
- 7) Steam header pressure, psig.
- 8) Feedwater deaerator steam pressure, psig.
- 9) Emergency gas valve status (open or closed).
- 10) Natural gas header pressure, psig.
- 11) Propane gas header pressure, psig.
- 12) Fuel oil header (emergency generator) pressure, psig.
- 13) Boiler feed header pressure - each header, psig.
- 14) LP igniter gas header pressure psig.
- 15) Instrument air pressure psig.
- 16) Fuel oil tank and piping leak detection in operation (emergency generator).

19. Specific Requirements - Historical Trending:

- a. Display No. 1 (one display per boiler): Individual boiler pressure-compensated steam flow rate, lb/hr; flue gas oxygen, percent; boiler stack temperature, °F; economizer flue gas outlet temperature, °F; percent opacity (if opacity monitor is provided); fuel flow rate (if fuel meters are provided on the boilers), scfh, feedwater flow rate (if feedwater meters are provided on the boilers) gpm.

- b. Display No. 2: Pressure-compensated steam flow rate for: total of all boilers; in-plant steam line; and each distribution steam line, lb/hr; total plant fuel flow rate, scfh.
 - c. Display No. 3: Outside air temperature, °F; feedwater temperature, °F; steam header pressure, psig.
20. Specific Requirements - Alarm Monitoring and Operation Log:
- a. Alarm Monitoring Sequence:
 - 1) Alarm occurs:
 - a) Monitor flashes alarm on all displays where point is shown.
 - b) Display screen point or group flashes.
 - c) Audible alarm sounds.
 - d) Identification of alarm point is displayed at bottom of monitor screen.
 - e) Printer logs alarm.
 - 2) Operator acknowledges alarm:
 - a) Audible alarm is silenced.
 - b) Alarm display stops flashing but remains highlighted.
 - 3) Point in alarm returns to normal after acknowledgment:
 - a) Alarm display clears.
 - b) Printer logs return to normal.
 - b. Alarm Summary Display: The alarm sequence summary display shall alert the operator when points are in alarm. The time of occurrence, point identification, type of alarm, engineering value, and point description shall appear on the display. The most recent alarm shall be shown at the top of the display, with time of occurrence displayed in hours, minutes, and seconds.
 - c. Operation Log: In addition to alarm conditions, this log shall also print status of pumps and burners (in service or out of service), status changes such as a transfer from auto to manual, set point change, etc., so that the resultant printout is a true and complete log of plant operations.
 - d. Alarm points shall include:
 - 1) Burner management safety control system alarms.
 - 2) Boilers high and low water level.
 - 3) Boilers low flue gas oxygen.
 - 4) Boilers high stack opacity (if opacity monitors are provided).

- 5) Condensate storage tank high and low water level.
 - 6) Feedwater deaerator high and low water level.
 - 7) Feedwater deaerator high and low steam pressure.
 - 8) High and low steam header pressure.
 - 9) Low feedwater pressure to each boiler.
 - 10) Emergency propane valve closed.
 - 11) Propane system alarm outputs.
 - 12) High and low natural gas header pressure.
 - 13) High and low oil level in each oil tank.
 - 14) Oil tank and piping system leak detected.
 - 15) Carbon monoxide (CO) or combustible gas in building.
 - 16) Control system faults.
 - 17) Emergency generator status.
21. Report Generation - Specific Requirements: The monitor shall display and the log sheet printer shall print out: instant, hourly, shift, daily and monthly plant operating reports. As a minimum, each report shall list:
- a. Maximum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
 - b. Minimum simultaneous instantaneous steam flow rate, combination of all boilers, lb/hr.
 - c. Totalization of steam produced, each boiler and combination of all boilers, lb.
 - d. Totalization of steam used in boiler plant, lb.
 - e. Separate totalization of steam exported into each distribution system, lb.
 - f. Totalization of oil consumed (emergency generator), gallons.
 - g. Totalization of natural gas consumed, mscf.
 - h. Totalization of liquid propane, gallons
 - i. Totalization of feedwater consumed, each boiler, gallons.
 - j. Overall boiler efficiency, fuel vs. steam (combination of all boilers).
 - k. Electricity used, kWh.
 - l. Make-up water used, gallons.
 - m. Make-up water as a percent of total steam production of all boilers combined.

- n. Number of heating degree-days.
 - o. Hours of operation of each boiler.
22. Communication with Burner Management (Flame Safeguard) Control Systems: Provide means to communicate with each burner safety control system to determine status, operating hours, flame signal strength, history of lockouts, number of short circuit events, other data necessary for remote trouble-shooting.
23. Monitor Screen Printout: Any display on the screen shall be able to be printed as required to provide hard-copy record.
- D. Sensors and Transmitters: Provide as necessary to satisfy programming requirements. Refer to paragraphs, PRESSURE SENSORS AND TRANSMITTERS and TEMPERATURE SENSORS AND TRANSMITTERS.

2.6 FLUE GAS OXYGEN ANALYZERS

- A. Oxygen content of flue gases of each boiler measured by zirconium-oxide in-situ systems with probe mounted in stack or breeching. Output to boiler/burner submaster controller for oxygen trim and computer work station. Single range, 0 to 10 percent oxygen.
- B. Performance:
 - 1. Minimum accuracy of plus or minus 2 percent of reading.
 - 2. Speed of response eight seconds or less to 90 percent accurate reading.
 - 3. Resolution 0.1 percent oxygen.
 - 4. These performance requirements are minimums and must be increased if necessary to suit the requirements of the oxygen trim system (if provided).
- C. Field-replaceable cell, heater, and cell temperature sensor. COR has the option of accepting long-term guarantee of unit exchange at favorable cost in lieu of capability of field-replacement of components.
- D. Reference and Calibration Air (if required by units furnished): Provide refrigerated air dryer and instrument quality compressed air supply to each unit. Coalescing color-change filter and pressure regulator at each analyzer.
- E. Automatic Calibration System: In-stack using bottled calibration gas mixtures containing oxygen and nitrogen. Number of mixtures and

composition as recommended by analyzer manufacturer. See paragraph, TOOLS.

1. Selectable manual/automatic calibration, which shall operate at preprogrammed intervals and upon power-up.
 2. Calibration gas piping system with permanently installed stop valves, pressure and flow regulators, pressure gauges, and flow meters to permit connection of gas bottles to unit. Locate all gas bottle connections, regulators, gauges and valves accessible from floor without use of ladders.
- F. Analyzer Displays: Operating parameters, process and diagnostic data, including percent oxygen, cell temperature, and set points of alarms and burner cutouts.
- G. Analyzer Outputs:
1. Modbus communications and analog output compatible with the boiler/burner submaster controller for flue gas oxygen trim and computer workstation.
 2. Low flue gas oxygen alarm on computer workstation and on main panel annunciator. Interface with burner management system to provide low oxygen shutdown of burner. Set point adjustable 0.5 to 3.0 percent oxygen. Set points shall not be adjustable from the front of the panel. Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES.

2.7 FLOW METERS

- A. Vortex Flow Meters with Transmitters:
1. Provide vortex-shedding flow meters designed for accurate measurement of flow rate ranges shown at required pressures. Minimum turndown capability shall be as scheduled. Meters shall have digital readout of pressure-compensated flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to the computer workstation . As an option, pressure compensation and the compensated flow rate may be performed and displayed by a boiler plant controller receiving signals from the flow meter and from a pressure transmitter. Refer to paragraph, PRESSURE SENSORS AND TRANSMITTERS.
 2. Programmable microprocessor electronics with on-board programming. Output signals immune to ambient temperature swings. Continuous

- self-diagnostic routines that identify electronics problems and provide a warning. Electronics replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics separate from meter body in position accessible from platform or floor without the use of a portable ladder.
3. All welded wafer-type or flanged stainless-steel meter body with no seals. No sensor parts exposed to the flow stream. Provide alignment rings with wafer-type meters to assure proper centering in the pipeline. Trapezoidal shedder bar, sensing by detecting stresses in the shedder bar caused by vortices, dual piezoelectric crystals located outside the process flow sense the shed vortices, dual crystal alignment cancels effects of noise and vibration. Designed for Schedule 40 piping.
 4. Transmitted signal accuracy plus or minus 1.5 percent of flow rate. Repeatability 0.2 percent of actual flow rate. Meter designed to minimize vibration effect and to provide elimination of this effect.
- B. Water Flow Meters:
1. Type: Continuous duty positive displacement disk or turbine type with meter-mounted totalizing registers.
 2. Service: Provide individual meters to measure volume of cold water, soft water as shown.
 3. Performance: Conform to scheduled flow range, accuracy, maximum pressure drop, maximum static pressure and temperature for the liquid shown. Minimum accuracy plus or minus 0.5 percent of flowrate over 10/1 turndown.
 4. Meter Construction:
 - a. Bronze or iron cases, threaded pipe connections, designed for 1034 kPa (150 psig) maximum pressure.
 - b. Registers: Hermetically sealed, magnetic coupling, digital flow rate readout or sweep hand registering one or ten gallons per revolution and digital register for totalizer with at least five digits. Provide horizontal register box with gasketed viewing glass and hinged cover. Register shall have capability of being positioned to any of the four cardinal points for readability. Transmit flow data to computer work station.

C. Turbine-Type Natural Gas Flow Meters:

1. Type: Turbine-type with volume totalizing digital readout that is continuously updated and corrected for the line pressure and temperature. Meter readouts shall be located on meter and in computer workstation . Meter shall be designed for natural gas at job site characteristics.
2. Performance: Maximum flow rate as scheduled. Pressure drop shall not exceed 1.25 kPa (5 inches WG). Accurate flow minimum turndown range shall be 10:1 with minimum accuracy one percent of flow rate over the entire range.
3. Construction:
 - a. Meter: Design for 861 kPa (125 psig). Pipe connections flanged 861 or 1034 kPa (125 or 150 psig) ANSI. All bearings and gearing shall be in areas sealed from contaminants. Metering transducers operated through magnetic coupling. The measuring devices shall be contained within a module that can be removed from the meter body for service and calibration without breaking the main gas piping connections. Corrosion-resistant material of construction or coating.
 - b. Indication Devices on Meter: Electronic type which provides a totalized continuous volume flow digital indication in cubic feet automatically continuously corrected to the local contract base temperature and pressure from actual varying line temperatures and pressures. Unit shall also display a totalized uncorrected volume flow indication. The display shall show actual line temperature and pressure at the meter and pressure-temperature correction factor. Smallest corrected flow indication shall be one thousand cubic feet, and indicator shall have at least six digits. Unit shall be watertight where drawings show an outdoor location.
4. Calibration: Factory calibrated. Furnish three-point curve spanning required flow range on actual meter furnished.
5. Accessories:
 - a. Remote Digital Register: Provide a remote digital register system including pulse generator and all wiring and accessories for proper functioning. Remote register shall have a digital cubic

feet volume readout corrected to the local contract base temperature and pressure from actual varying line conditions. Smallest indication shall be one thousand cubic feet, and indicator shall have at least six digits. Provide 120-volt power supply from panel. Individual boiler registers shall be located near boiler control panels.

- b. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.
- c. Filter: Shall have replaceable glass fiber or cellulose cartridge with ten micron or smaller particle retention. Filter enclosure shall be the pipe size of the meter or larger as required by pressure drop considerations. Static pressure capability shall be at least twice lockup pressure of service supply regulators. Maximum pressure loss 1.25 kPa (5 inches WG) at maximum design flow rate of meter. Plug all drains or instrumentation outlets. Provide vent with cock for relieving pressure in filter.

2.8 BOILER STACK OPACITY MONITORS (NOT REQUIRED)

2.9 PRESSURE SENSORS AND TRANSMITTERS

- A. Transmitters for gauge pressure, differential pressure, fluid level, and draft utilized for instrumentation, computer workstation, and controls.
- B. "Smart" programmable electronics, sealed diaphragms, direct-sensing electronics, no mechanical force or torque transfer devices, non-interactive external span and zero adjustment, solid-state plug-in circuit boards. Minimum accuracy plus or minus 0.1 percent of calibrated span. 40:1 minimum rangeability. Communication system shall be compatible with boiler plant controls and instrumentation.
- C. Shut-off and blowdown valves on all transmitters.
Equalizing/calibration manifold valves on all differential pressure and fluid level transmitters. Connection points to permit calibration of system with a portable pressure calibrator.
- D. Reservoirs for transmitter piping connections where an interface between liquid and steam is present, such as boiler water level sensing and differential pressure steam flow meter applications.
- E. Provide and deliver to COR all hardware and software necessary for field calibrating and programming all transmitters.

F. Spare Parts: One transmitter of each type utilized in the project.

2.10 BOILER DRAFT GAUGES

- A. For fire tube boilers, provide gauges for boiler outlet and economizer outlet.
- B. Type: Analog, multiple vertical scale, dry diaphragm, balanced pointers, semi-flush-mounted, zero adjustment.
- C. Scales: Internally illuminated, minimum length 125 mm (5 inches), scale ranges coordinated with equipment furnished and actual operating conditions, scales labeled for the service. If, in operation, indicators go under-range or over-range, the gauges shall be replaced with greater ranges, at no additional cost or time to the Government. Scales for furnace, boiler outlet, and economizer outlet gauges must be combination negative and positive pressure.
- D. 3-way cock for each gauge to permit shut-off, connection to service, connection to atmosphere.
- E. Mount on boiler/burner control panel.

2.11 TEMPERATURE SENSORS AND TRANSMITTERS

- A. Provide resistance temperature detectors (RTD).
- B. Provide transmitters or panel-mounted indicator transmitters, transducers, and receivers compatible with the system including the controllers computer workstation.
- C. Minimum accuracy one percent of actual temperature.
- D. Boiler and economizer flue gas temperature sensors shall be averaging type and shall extend across width of stack or breeching.
- E. Provide stainless steel weather hood on outside air temperature sensor, which shields the sensor from direct sunlight.

2.12 RECORDERS (NOT USED)

2.13 GAUGES, PRESSURE AND COMPOUND, PIPE OR TANK-MOUNTED

- A. Construction:
 - 1. Case: Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
 - 2. Dial: Non-corrosive, 115 mm (4-1/2 inch) diameter face with black markings on white background.
 - 3. Measuring Element: Bourdon tube designed for the required service. Provide bellows designed for service for pressure ranges under 103 kPa (15 psig).

4. Movement: Stainless steel, rotary.
 5. Pointer: Micrometer adjustable, black color.
 6. Window: Plastic.
 7. Liquid Filled Gauges: Provide at inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners where bourdon tube gauges are utilized. Gauge filling shall be glycerin or silicone oil. Purpose of filling is to provide pulsation dampening. As an option to liquid filling, provide dry gauges that have built-in fluid clutch dampeners that are not vulnerable to plugging due to foreign material.
- B. Accuracy: ASME B40.100, Grade 2A, 1/2 percent, on all gauges; except Grade A, one percent permitted on diaphragm actuated gauges, liquid-filled gauges, and compound gauges.
- C. Accessories:
1. Red set hands on gauges located at automatic pressure regulator valve outlets.
 2. Needle valve or gauge cock rated for the service.
 3. Syphon on all steam gauges.
 4. Pulsation snubbers on diaphragm-type gauges located adjacent to gas burners.
- D. Scale Ranges: Provide English scales:
1. Low pressure steam up to 15 psig: 0 to 29 psig.
 2. Medium pressure steam up to 59 psig: 0 to 100 psig.
 3. High pressure steam above 59 psig: 0 to 200 psig.
 4. Natural and LP gas: 0 to 29 psig.
 5. LP gas at tanks: 0 to 300 psig.
 6. Gas burner, 125 percent of full load pressure, kPa/inches WG.
 7. Compressed air, 50 psig & higher: 0 to 160 psig.
 8. Feedwater pump discharge: 0 to 300 psig.
 9. Feedwater pump suction: 30 inches Hg vacuum to 29 psig.
 10. Pumped condensate: 0 to 60 psig.
 11. Condensate transfer pump discharge: 0 to 60 psig.
 12. Condensate transfer pump suction: 30 inches Hg vacuum to 15 psig.
 13. Feedwater deaerator: 30 inches Hg vacuum to 29 psig.
 14. Other services, 200 percent of maximum operating pressure.

E. Boiler Steam Pressure Gauges: Refer to Section 23 52 39, FIRE-TUBE BOILERS.

F. Panel-mounted Gauges: Refer to paragraph, MAIN INSTRUMENTATION AND CONTROL PANEL.

2.14 THERMOMETERS, PIPE OR TANK-MOUNTED

A. General: Thermometer locations are shown on the drawings.

B. Construction:

1. Industrial type, separable well and socket, union connected.
2. Scales: Red reading mercury combination 0 to 150 degrees Celsius/30 to 302 degrees Fahrenheit scales, unless otherwise shown. Scale length 225 mm (9 inch). Mercury sealed under pressure with inert gas to prevent oxidation and separation of column.
3. Case: Corrosion resistant with glass or plastic front.
4. Form: Straight or back form except thermometers located more than 2100 mm (7 feet) above floor or platform shall be adjustable angle.
5. Wells: Sized to suit pipe diameter without restricting flow. Provide snug sliding fit between socket and well.
6. Accuracy: One percent of scale range.

2.15 BOILER PLANT BUILDING DANGEROUS GAS DETECTION SYSTEM, CARBON MONOXIDE AND COMBUSTIBLE GAS

A. Relocate existing sensors as directed in drawings. Modify existing system to report to new main boiler plant control system.

2.16 TOOLS

A. Portable Deadweight-Type Pressure Gauge Tester:

1. Type: Portable hydraulic deadweight tester with minimum range of 7 to 300 psig.
2. Accuracy: Within plus or minus 0.1 percent of indicated pressure traceable to National Institute of Standards and Technology (NIST).
3. Construction: Steel or aluminum carrying case, compact design unit with weights and pump fitting within one carrying case, weights replaceable without replacing remainder of apparatus.
4. Accessories: Gauge pointer puller, 6 mm (1/4 inch) and 15 mm (1/2 inch NPT) pressure gauge connectors, sufficient hydraulic fluid to fill tester three times, all tools recommended by manufacturer.
5. Delivery: Deliver to COR for use by VA personnel only. Deliver prior to boiler tests.

- B. Portable Digital-Type Pressure Gauge Tester:
1. Type: Portable digital pressure calibrator with a minimum range of 7 to 200 psig.
 2. Accuracy: Within plus or minus 0.04 percent of indicated pressure traceable to National Institute of Standards and Technology (NIST).
 3. Construction: Steel or aluminum carrying case, compact design unit with hand pump, fittings for connecting to pressure gauges and pump, test leads.
 4. Accessories: Gauge pointer puller, 6 mm (1/4 inch) and 15 mm (1/2 inch NPT) pressure gauge connectors, all tools recommended by manufacturer for testing pressure gauges.
 5. Delivery: Deliver to COR for use by VA personnel only. Deliver prior to boiler tests.
- C. Calibration Gases for Boiler Flue Gas Oxygen Analyzers and Building Carbon Monoxide and Combustible Gas Detection System:
1. Type: Compressed gases in transportable cylinders, certified analyses. One cylinder of each mixture for each analyzer. Composition of mixtures and quantity of mixtures as recommended in written instructions by analyzer and gas detection system manufacturers.
 2. Cylinders: Minimum capacity 100 liters (26.4 gallons) of gas, approx. 75 x 355 mm (3 x 14 inch) cylinder.
 3. Delivery: Deliver to COR prior to initial calibration of instrumentation. Contractor personnel may use gases. Provide new full cylinders, to replace gases used during start-up and testing after boiler plant testing is complete.
- D. Communication Devices for Programming Instrumentation and Controls:
Furnish all devices necessary to configure all programs and obtain all data from instruments and controls. Deliver to COR.

PART 3 - EXECUTION

3.1 GENERAL

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 INSTALLATION, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORK STATION (IF PROVIDED)

A. General:

1. Nameplates, Labels and Identification: Refer to Section 23 05 10, COMMON WORK RESULTS FOR 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; Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES; and Section 26 27 26, WIRING DEVICES. The term "wiring" includes furnishing of wire, conduit, miscellaneous material and labor to install a complete working system as specified.
4. All devices plumbing and wiring shall comply with and be arranged as shown in the VHA Boiler Plant Safety Devices 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 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 gauge 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.
 10. Flexible conduit of any type is limited to 900 mm (3 feet) in length unless longer runs are required for access to equipment such as opening the front door of a boiler.
 11. Conduit smaller than 50 mm (1/2 inch) is prohibited.
 12. All electrical conductors shall be installed in conduit.
(Including SO Cord).
- B. Pressure, Temperature, Level and Flow Transmitters: Mount in locations accessible from floor or platform without use of portable ladders. Provide separate conduit for each transmitter signal. Protect sensor or controller on steam or water service by an adequate water seal at all times and provide blowdown facilities to permit blowdown of sensing lines. Install temperature sensors with entire temperature sensing surface immersed in media being measured. Locate outside air temperature sensor on north side of building away from heat sources. Provide isolation valves on all transmitters connected to fluid systems. Locate isolation valves so that transmitter can be isolated while main sensing line is being blown down. Provide equalizing valves on all differential pressure transmitters. Provide valved drains on all fluid lines. Valves shall be rated for minimum of 150 percent of system pressure and temperature.
- C. Steam Flow Meter Primary Elements (In-Line Flow Sensors) including Vortex-Shedding Type: Provide straight runs of piping upstream and downstream as recommended by manufacturer to achieve maximum accuracy and rangeability. Verify that stresses in piping system do not exceed allowable stress of flow meter body. Locate meter electronics including

read-out devices accessible from floor or platform without the use of portable ladders.

D. Flue Gas Oxygen Analyzers:

1. Mounting: Provide freestanding floor-mounted steel rack for mounting control panels and read-outs. Position panels and readouts 1500 mm (5 feet) above the boiler room floor.
2. Sampling point shall be upstream of smoke density monitor in non-turbulent area. Locate probe within 4.6 meters (15 feet) of floor or accessible from platform.
3. Reference Air: Provide dry, filtered, pressure-regulated compressed air service to each unit. Provide isolating valve at each unit.
4. Calibration Gases: Provide permanently installed valved piping connections, pressure regulators and gauges in flue gas sampling system for connection of required calibration gases. Locate within 1200 mm (4 feet) of main floor.
5. Interconnection of Instruments: Provide shielded wiring as recommended by instrument manufacturer.
6. Power Circuits: Provide dedicated circuits from a plant panel. Analyzers shall remain powered when burner control is off.

E. Wiring and Piping: Is generally not shown on the drawings. All wiring and piping must be provided in accordance with NFPA 70 and ASME B31.1.

F. Combustion Control Linkage Systems: After completion of burner adjustments, counter sink all lever set screws into shafts or pin levers to shafts to prevent levers from slipping on the shafts.

G. Compressed Air Filters: Pipe drain to nearest floor drain.

3.3 INSTALLATION, NATURAL GAS FLOW METERS

A. Entire installation shall conform to recommendations of the meter manufacturer for obtaining the most accurate flow measurements. Arrange meter readout so that it is visible from nearest walkway or service platform.

3.4 INSTALLATION, PRESSURE GAUGES

A. Orient gauges so that dials are upright and visible from the nearest walkway or access platform. Install gauges with gauge cocks. Provide pig-tail syphons on steam service. Provide compound gauges on all pump suction lines and on feedwater deaerator; provide pressure gauges elsewhere. Install liquid-filled or equivalent (as specified) gauges at

inlet and outlet of all pumps, on compressed air systems, and on fuel and atomizing media lines at locations closest to burners. If diaphragm-type gauges are used, provide pulsation dampeners instead of liquid filling.

3.5 INSTALLATION, THERMOMETERS

- A. Arrange thermometers so that scales are upright and visible from nearest walkway or access platform. Provide adjustable angle thermometers on applications more than 2100 mm (7 feet) above floor or platform. Tilt the angle type thermometers for proper view from floor or platform. Locate wells in flow stream.

3.6 INSTALLATION, WATER FLOW METERS

- A. Provide strainer upstream with 80-mesh screen liner. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS. Position register for upright viewing from nearest walkway.

3.7 TESTING, BOILER PLANT INSTRUMENTATION, AUTOMATIC BOILER CONTROL SYSTEMS, BURNER MANAGEMENT SYSTEMS, COMPUTER WORKSTATION (IF PROVIDED)

- A. Representatives of the designer of the system shall demonstrate proper operation and calibration of all components, computer programs, and entire systems to the COR. If the project includes boiler/burner testing, the demonstration involving boiler/burner data shall be conducted during the boiler/burner tests. Furnish personnel, instrumentation, and equipment necessary to perform calibration and testing. All calibration work must be completed prior to the testing.
- B. Burner Management (Safety Control) Systems: All tests shall be based on the VHA Boiler Plant Safety Devices Testing Manual, also Refer to Section 23 52 39, FIRE-TUBE BOILERS.
- C. Steam Flow Measuring: Demonstrate proper calibration of each flow rate signal and indication and each totalizer signal and indication to COR or their representative prior to the start of the final boiler testing.
- D. Testing shall demonstrate proper calibration of input and output devices, the proper operation of all equipment, proper execution of the sequence of operation, proper tuning of control loops and maintaining of all set points.
- E. Document all tests with detailed report of test results. Explain in detail the nature of each failure and corrective action taken.

- F. 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, and retest. Provide written report to COR.
- G. Demonstrate all safety and operating interlocks.
- H. 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.
- I. Furnish to 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.
- J. 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.
- K. Computer Workstation Software Operation Test:
 - 1. Test ability to properly communicate with and operate the control systems.
 - 2. Demonstrate the ability to edit the programs off and on line.
 - 3. Demonstrate operation of all alarm points.
 - 4. Demonstrate the receipt, display, and saving of trend and status reports.
 - 5. Demonstrate display and operation of all graphics.
 - 6. Demonstrate all program calculating functions and report generation.
 - 7. Demonstrate proper operation of all printers.

3.8 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

- C. The Commissioning Agent shall observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.9 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification shall be tested as part of a larger system.

3.10 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 24 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

**SECTION 23 10 00
FACILITY LIQUID PROPANE GAS SYSTEMS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Liquid Propane tanks, piping, pump package, vaporizer/air mixer and accessories located outside aboveground as shown on contract drawings. Refer to contract drawings for type of fuel and for tank capacities.
- B. Tank fluid level monitoring and alarm systems.
- C. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- F. Section 05 50 00, METAL FABRICATIONS.
- G. Section 09 91 00, PAINTING.
- H. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- I. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- J. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- K. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- L. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- M. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- N. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.
- O. Section 31 20 00, EARTHWORK.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
B16.5-2017Pipe Flanges and Flanged Fittings: NPS 1/2
through NPS 24 Metric/Inch Standard.

- B16.9-2018Factory Made Wrought Buttwelding Fittings
- B16.11-2016Forged Fittings, Socket-Welding and Threaded
- B31.1-2018Power Piping
- C. American Society for Testing and Materials (ASTM):
- A36/A36M-2017Standard Specification for Carbon Structural Steel
- A53/A53M-2018Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- A105/A105M-2014Standard Specification for Carbon Steel Forgings for Piping Applications
- A106/A106M-2015Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- A126-04 (R2019)Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- A234/A234M-2015Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- B62-2017Standard Specification for Composition Bronze or Ounce Metal Castings
- D2996-2015Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
- D. Federal Specifications (Fed. Spec.):
- A-A-60005/1998Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole
- E. NACE International (NACE):
- SP0169-2013Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- 3/SSPC-SP62013Commercial Blast Cleaning
- 4/SSPC-SP72006Brush-off Blast Cleaning
- F. National Electrical Manufacturers Association (NEMA):
- 250-2014Enclosures for Electrical Equipment (1000 Volts Maximum)
- G. National Fire Protection Association (NFPA):
- 58-2020Liquefied Petroleum Code.

70-2017National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**INFORMATION AND MATERIAL SUBMITTED UNDER THIS SECTION SHALL BE MARKED
"SUBMITTED UNDER SECTION 23 10 00, LIQUID PROPANE GAS SYSTEMS**

- B. FACILITY FUEL OIL SYSTEMS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Aboveground Steel Tanks:
1. Drawings of tanks, supports, tank manholes, emergency relief vents and all accessories. Include overall dimensions and dimensional locations and sizes of pipe connections, and access openings.
 2. Recommended tank support locations.
 3. Weight of entire tank assembly, empty and flooded.
 4. Design and construction of primary tanks, supports, pipe connections.
 5. Application and performance data on coatings from manufacturer of coatings.
 6. Certification of compliance with specified standards.
 7. Design, construction, performance, ASME rating, dimensions of emergency relief vents.
- E. LP Piping:
1. ASTM and UL compliance.
 2. Grade, class or type, schedule number.
 3. Manufacturer.
- F. Pipe Fittings, Unions, Flanges:
1. ASTM and UL compliance.
 2. ASTM standards number.
 3. Catalog cuts.
 4. Pressure and temperature rating.
- G. Valves, Check Valves:
1. Catalog cuts showing design and construction.

2. Pressure and temperature ratings.
 3. Pressure loss and flow rate data.
 4. Materials of construction.
 5. Accessories.
- H. Tank and Piping Accessories: Design, construction, and dimensions of relief valves, fill station, and other accessories.
- I. LPG Vaporizer/Air Mixer:
1. Drawings of vaporizer, skid, controls and all accessories. Include overall dimensions and dimensional locations and sizes of pipe connections, and openings.
 2. Weight of entire assembly, empty and flooded.
 3. Design and construction of skid and pipe connections.
 4. Application and performance data on coatings from manufacturer of coatings.
 5. Certification of compliance with specified standards.
 6. Design, construction, performance, dimensions of emergency relief vents.
- J. Pump skid:
1. Drawings with dimensions of assemblies of pumps and drivers.
 2. Catalog data and specification sheets on design and construction of pumps, drivers and couplings (flexible-coupled units).
 3. Motor efficiency and power factor at full load.
 4. Performance curves showing discharge head, required flow plus recirculation, net positive suction head required, efficiency, driver power, impeller diameter to be furnished. Refer to drawings for requirements.
 5. Pressure and temperature limitations of pump unit and accessories.
- K. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

- L. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- M. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers, and will be based on Contractor's certification that:
 - 1. Manufacturers regularly and currently manufacture propane tanks, tank and piping accessories, and tank fluid level monitoring.
 - 2. The design and size of each item of equipment provided for this project is of current production and has been in satisfactory operation on at least three installations for approximately three years. Current models of fluid level and leak detection systems with less than three years' service experience are acceptable if similar previous models from the same manufacturer have at least three years' service experience.
- B. Apply and install materials, equipment and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the COR for resolution. Provide copies of installation instructions to the COR two weeks prior to commencing installation of any item.
- C. All equipment shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components or overall assembly.
- D. Tanks, Piping: Authorized manufacturer's representatives shall provide onsite training of installers and supervision of the installation and testing of the equipment and systems to assure conformance to written instructions of manufacturers.
- E. Tank and piping installation contractor shall be certified as acceptable by local and state pollution control authorities.
- F. Entire installation shall conform to requirements of local and state pollution control authorities.

- G. Pipe Welding: Conform to requirements of ASME B31.1. Welders shall show evidence of qualification. Welders shall utilize a stamp to identify their work. Unqualified personnel will be rejected.
- H. Where specified codes or standards conflict, consult the COR.
- I. Label of Conformance (definition): Labels of accredited testing laboratories showing conformance to the standards specified.
- J. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a safe, complete and fully operational system which conforms to contract requirements and in which no item is subject to conditions beyond its design capabilities.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.7 PERMITS

- A. Contractor shall obtain and complete all tank permit and registration forms required by governmental authorities.

PART 2 - PRODUCTS

2.1 ABOVEGROUND STEEL TANKS

- A. Type: Factory-fabricated all welded steel, horizontal cylindrical configuration, Modified ASME vessel - 250 PSIG.
- B. Construction:
 1. Conforms to the latest edition of ASME rules of construction of pressure vessels, Section VIII, Division 1. Shall bear ASME seal.
 2. Conform to NFPA 58.
 3. Rated at 250 PSIG from -20F to 125F.
 4. Vessels shall be registered with the national board.

5. Leaks and abrasions are prohibited. Maximum permissible out-of-roundness of cylindrical shells is one percent of the diameter.
6. Provide lifting lugs for rigging tanks.
- C. Factory Cleaning: Clean interior and exterior of tanks. Remove mill scale, dirt, rust, oil, welding debris, loose coatings and coatings incompatible with fuel stored or protective coating. Sandblast exterior in accordance with NACE 3.
- D. Factory Coating: Vessels are either powder coated with TGIC polyester or primed with liquid epoxy and coated with liquid urethane top coat.
- E. Vessels shall be shipped vacuum pre-purged to enable simplified first fill of the vessel.
- F. Pipe Connections to Tanks:
 1. Pipe sizes shall be threaded.
 2. Welded joints required on steel piping located inside tanks.
 3. Provide and coordinate tank connection quantities, sizes and types with requirements of tank level gauge unit; sounding rod; vent, fill, supply and return pipes; and other pipes as shown.
- G. Tank Manholes: Provide quantity shown. Bolted cover type, gasketed.
- H. Internal Ladder: Provide as shown with 50 mm x 6 mm (2 inch x 1/4 inch) sides and 20 mm (3/4 inch) diameter rungs at 300 mm (12 inches) on center. Provide slide supports to allow for tank movement.
- I. Lifting Lugs: Provide for rigging tanks.
- J. Emergency Relief Vents: Venting capacity shall conform to NFPA 58 as applicable. Vent shall be a standard product of a manufacturer, designed to automatically open at tank pressure of 250 PSIG. Aluminum or cast-iron construction with Teflon seating surface. Provide separate vents for primary and secondary tanks.
- K. Provide fittings for grounding per NFPA 70.

2.2 LPG VAPORIZER

- A. LPG Vaporizer shall be horizontal water bath heat exchanger type with integrated gas-fired heat source. The LPG/Air Mixer shall be installed on the same skid as the vaporizer and all associated equipment shall be provided by same manufacturer. See following paragraph for LPG Air/mixer requirements.

- B. The LPG heat exchanger of the vaporizer shall be designed and manufactured in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. The vaporizer shall be designed and manufactured in compliance with all applicable sections of the latest edition of NFPA 58 and NFPA 70.
- D. The vaporizer shall be FM approved; the control panel can be optionally UL-508a stamped; the LPG heat exchanger can optionally carry the ASME "U"-Stamp.
- E. The vaporizer shall be skid mounted; the sides of the bath box shall be insulated and shall be covered with powder-coated sheet metal panels; the top of the vaporizer shall be covered with powder-coated sheet metal panels. The burner shall Forced Draft Power Burner with Electric Blower
- F. Controls:
 - 1. All burner safety functions of the vaporizer shall be controlled by a microprocessor-based Flame Safeguard system.
 - 2. Other System Parameters on the vaporizer shall be controlled by a Programmable Logic Controller (PLC) in the system control panel, which shall be shared with the LPG/Air mixer.
 - 3. The PLC shall communicate with an Electronic Operator Interface (EOI) with high-resolution color LCD display and touchscreen operator interface. The display shall show all relevant operating parameters and process values (pressures, temperatures), and shall have a size of 9.7 inches or greater. It shall provide event logs, graphic trend recording, and local data storage on flash memory for a minimum of two years. The EOI shall have built-in remote access capability via VNC server. Any software that is required for remote access via VNC shall be included in the supply.
 - 4. The vaporizer shall be equipped with a mechanical thermostat in the water bath, and a thermostat with manual reset as the high-bath-temperature cutoff.
 - 5. The vaporizer shall be equipped with a "smart" liquid carryover protection, where vapor pressure and temperature are constantly monitored by a dedicated pressure transmitter and a temperature transmitter. Their signals shall be processed in the PLC and shall be compared against the vapor pressure/temperature saturation curve

- of the LPG that is being vaporized. The properties of the LPG (Propane/Butane percentage), and the safety margin (how close the pressure/temperature are allowed to come to the saturation curve) shall be entered through the operator interface. If the safety margin is crossed, the liquid inlet solenoid valve shall be closed after an adjustable alarm delay period has elapsed.
6. The vaporizer shall be equipped with an agency-approved safety system (either a separate safety controller or a safe PLC). This safety system shall monitor the local ESD circuit and shall make an independent ESD circuit available for input from a site ESD system. The safety system shall also generate an available output to the on-site ESD system.
 7. The safety system shall also provide safe inputs for alarm contacts from an optional gas leak monitor (if equipped).
 8. The safety controller shall notify the operator if it requires a manual reset after an ESD has tripped. The reset button for the safety controller shall be accessible without having to open the vaporizer control panel.
- G. The supplier shall include the initial charge of Heat Transfer Solution as an option. The Heat Transfer Solution shall consist of a pre-mixed solution of DI-water and buffered Propylene Glycol with a corrosion inhibitor package. Solution shall protect the system to -30F.
- H. Safety Features:
1. Ignition Failure Safety Shut Down;
 2. Low Water Level Cutoff;
 3. High Water Bath Temperature Cutoff;
 4. "Smart" Liquid Carryover Protection (see above);
 5. Pressure Relief Valve Protection (Vapor Tube);
 6. Pressure Relief Valve Protection (Burner Train);
 7. Low Burner Gas Pressure;
 8. High Burner Gas Pressure;
 9. Proof-of-Closure Interlock;
 10. Combustion Air Flow Interlock;
 11. Flame Rod Flame Sensor.
 12. A gas leak monitor with long-life IR sensor can be installed in the vaporizer control room. If installed, the gas leak monitor shall

have a redundant relay output for 40% LEL, an independent output for sensor trouble, and a 4-20 mA analog output for 0-100% LEL.

2.3 LPG AIR MIXER - VENTURI

- A. The LPG/Air Mixer shall be installed on the same skid as the vaporizer. The LPG/Air mixer shall be based on the Venturi principle and shall consist of multiple mixer trains of fixed capacity. The mixer shall be designed for outdoor installation and shall include a skid-mounted surge tank. The LPG/Air mixing ratio shall be adjustable. The controls for the LPG/Air mixer shall be integrated into the vaporizer controls and shall include a cycle counter to record the activations for each Venturi train. Each cycle counter shall have a reset function that is independent from the other cycle counters. System discharge pressure and Venturi on/off setpoints shall be adjustable through inputs at the operator interface.
- B. The LPG/Air mixer shall be designed and manufactured in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. The LPG/Air mixer shall be designed and manufactured in compliance with all applicable sections of the latest edition of NFPA 58 and NFPA 70.
- D. The LPG/Air mixer shall be FM approved; the control panel shall be UL-508a stamped.
- E. The LPG/Air mixer shall be skid mounted.
- F. Controls shall be provided and co-located in the vaporizer skid. The following functions shall be provided:
 - 1. The mixer shall share its PLC and the Electronic Operator Interface (EOI) with the vaporizer. All connections between the mixer skid and the control panel in the vaporizer control room shall be factory-installed.
 - 2. All terminals and wires inside the control panel shall be permanently marked with identical terminal markers at both termination points.
 - 3. The Electronic Operator Interface (EOI) shall show all relevant operating parameters and process values (pressures), and shall have a size of 9.7 inches or greater.
 - 4. It shall provide event logs; graphic trend recording; and local data storage for a minimum of two years. The EOI shall have built-in

remote access capability via VNC server. Any software that is required for remote access via VNC shall be included in the supply.

5. The EOI shall also be used for the initial system setup. The operator shall be able to modify all settings through simple inputs at the touch screen display. The operator guidance shall be intuitive to reduce training and maximize retention.

G. Safety Features:

1. All system status signals shall constantly be monitored through a Programmable Logic Controller (PLC). Process values and any alarm conditions shall be communicated to, and displayed at, the EOI in "plain English".
2. Each Venturi train shall be equipped with an additional solenoid valve that is not exercised with each Venturi activation. These solenoid valves shall be of fail-safe closed design and shall act as an additional safety feature, to be de-energized when control power is removed from the system; when a power failure occurs; when an ESD circuit trips; or when a high-pressure condition is detected.
3. MixGas Pressure High/Low Alarm
4. Vapor Pressure High/Low Alarm

H. Provide factory mounted pressure indicators:

1. MixGas: Gauge, stainless steel case, liquid filled
2. Vapor: Gauge, stainless steel case, liquid filled

I. Provide factory mounted temperature indicators:

1. MixGas Thermometer, 2.5in, stainless steel
2. Vapor Thermometer, 2.5in, stainless steel

2.4 LIQUID TRANSFER PUMPS

- A. The Liquid Transfer Pump will be used to transfer liquid propane to the vaporizer and set the operational pressure of the Synthetic Natural Gas (SNG) system. Duplex pumps shall be provided, with a single pump shall be sized to supply 100% of the system capacity. The pump shall be skid-mounted. If a magnetic motor starter is required, they shall be installed inside the vaporizer control room and shall be integrated into the ESD system.
- B. The pump shall be designed and manufactured in accordance with NFPA 58 & NFPA 70 and shall be suitable for installation in hazardous areas classified as Class I, Division I, Group D (Flame Proof).

- C. The Liquid Transfer Pump shall be skid mounted.
- D. The pump controls shall be an integral part of the vaporizer/blender control system. A pressure transmitter shall measure the pressure in the storage tank(s) and shall automatically start/stop the pump at adjustable setpoints.
- E. The pump shall also be controllable through manual inputs at the touch screen operator interface, and through a start/stop station that is installed at the pump skid.
- F. The pump shall be equipped with a check-valve bypass for system operation at times when the available tank pressure does not require operating the pump.
- G. The pump skid shall be equipped with isolation and bypass valves. All pressure gauges on the pump skid shall be liquid-filled.
- H. The motor starters for the pump shall be installed inside the vaporizer control room. The motor starters shall be integrated into the local ESD system and into the plant ESD system and shall be de-energized when either system trips, or when the gas leak monitor in the vaporizer issues a shutdown command.

2.5 PIPING, VALVES, FITTINGS

- A. LP supply and return, tank fill, vents, and pump out.
- B. Steel Pipe and Fittings:
 - 1. Piping: Steel, seamless or electric resistance welded (ERW), ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, Schedule 40. Aboveground piping shall be painted. Refer to Section 09 91 00, PAINTING.
 - 2. Joints: Socket or butt-welded. Threaded joints are prohibited except at valves, unions and tank connections.
 - 3. Fittings:
 - a. Butt-welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - b. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
 - 4. Unions: Malleable iron, 2070 kPa (300 psig) class.
 - 5. Companion flanges: Flanges and bolting, ASME B16.5.
 - 6. Welding flanges: Weld neck, ASME B16.5, forged steel ASTM A105/A105M, 1034 kPa (150 psig).

- C. High Density Polyethylene (HDPE) piping.
 - 1. Must meet ASTM d-2513 and PE2406/2708.
 - 2. Plastic piping allowed in underground use only.
- D. Check Valves - LP Pump Suction.
 - 1. Pipe Sizes 50 mm (2 inches) and under: Rated for 1375 kPa (200 psig) water-oil-gas, swing-type, threaded ends, ASTM B62 bronze body. Provide union adjacent to valve.
 - 2. Pipe Sizes 65 mm (2-1/2 inches) and above: Rated for 1380 kPa (200 psig) water-oil-gas, swing-type, 861 kPa (125 pounds) ASME flanged ends, ASTM A126 class B cast iron body.

2.6 CONCRETE FOUNDATIONS

- A. Concrete ballast foundations for underground tanks and concrete pads for aboveground tanks are specified under Section 03 30 00, CAST-IN-PLACE CONCRETE. Ballast foundations shall be sized for buoyancy of entire tank when empty. Credit for overburden is allowed.

2.7 BURIED UTILITY WARNING TRACING TAPE

- A. Tape shall be 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1740 psig) lengthwise and 10,342 kPa (1500 psig) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Insulating and labeling shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 GENERAL

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 INSTALLATION AND TESTING, ABOVEGROUND TANKS

- A. Conform to NFPA 58 as applicable.
- B. Support tanks on steel saddles welded to the tanks. Anchor to concrete foundations. Provide molded neoprene isolation pads between the steel supports and the concrete foundation.
- C. Provide electrical grounding in accordance with NFPA 70.

3.3 INSTALLATION AND TESTING, UNDERGROUND PIPING SYSTEMS

- A. Steel Fuel and Tracing Media Carrier Piping: All joints butt or socket welding. Threaded piping is prohibited. Piping ends shall be accurately cut, true, and beveled for welding.
- B. High Density Polyethylene (HDPE): below grade LPG: Install in accordance with printed instructions of pipe manufacturer. Installation personnel trained in accordance with paragraph, QUALITY ASSURANCE.

3.4 INSTALLATION, VAPORIZER/AIR MIXER AND PUMP SKIDS

- A. Manufacturer shall provide start up and testing, and commissioning support for the pre-assembled skids.

3.5 INSTALLATION, BURIED UTILITY WARNING TRACING TAPE

- A. Install tracer wire in the trench approximately 457 mm (18 inches) above the non-metallic pipe. The tracer wire shall be taped approximately every 3 m (10 feet) to the pipe, where practical. The tracer wire shall be installed so that electrical continuity is maintained throughout the pipe system. As few connections as possible shall be made in the tracer wire. The wire shall be contiguous except at test stations, valve boxes, and where splicing is required. All splices shall be encased. Connections will be made by stripping the insulation back one inch and joining the two ends using an approved mechanical connector and a split bolt connector. Twisting of copper wire is prohibited. To complete this connection, wrap all exposed wire thoroughly with electrical tape. A minimum 1.5 m (5 foot) of additional tracer wire will be coiled, buried and terminate aboveground at the ends of the pipeline.

3.6 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing

schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.7 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.8 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 8 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

**SECTION 23 21 11
BOILER PLANT PIPING SYSTEMS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. All boiler plant piping systems, except plumbing and sanitary, including piping supports. Piping located outside of the boiler plant building is not included except for gas regulator and meter stations.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 09 91 00, PAINTING.
- F. Section 22 11 00 FACILITY WATER DISTRIBUTION.
- G. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- H. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- I. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- J. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- K. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
- L. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- M. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- N. Section 23 52 39, FIRE-TUBE BOILERS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Civil Engineers (ASCE):
 - 25-2006Earthquake-Actuated Automatic Gas Shutoff
Devices

C. American Society of Mechanical Engineers (ASME):

B16.3-2011Malleable Iron Threaded Fittings: Classes 150
and 300

B16.5-2013Pipe Flanges and Flanged Fittings: NPS 1/2
Through NPS 24 Metric/Inch Standard

B16.9-2018Factory Made Wrought Buttwelding Fittings

B16.11-2016Forged Fittings, Socket-Welding and Threaded

B16.22-2018Wrought Copper and Copper Alloy Solder-Joint
Pressure Fittings

B16.34-2017Valves Flanged, Threaded and Welding End

B31.1-2014 (R2017)Power Piping

B31.9-2014Building Services Piping

ASME Boiler and Pressure Vessel Code (BPVC):

BPVC Section I-2019Rules for Construction of Power Boilers

BPVC Section VIII-2019 Rules for Construction of Pressure Vessels

BPVC Section IX-2019 Welding, Brazing, and Fusing Qualifications

D. ASTM International (ASTM):

A47/A47M-2018Standard Specification for Ferritic Malleable
Iron Castings

A53/A53M-2018Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless

A105/A105M-2018Standard Specification for Carbon Steel
Forgings for Piping Applications

A106/A106M-2019Standard Specification for Seamless Carbon
Steel Pipe for High-Temperature Service

A193/A193M-2019Standard Specification for Alloy-Steel and
Stainless-Steel Bolting for High Temperature or
High-Pressure Service and Other Special Purpose
Applications

A194/A194M-2018Standard Specification for Carbon Steel, Alloy
Steel, and Stainless-Steel Nuts for Bolts for
High Pressure or High-Temperature Service, or
Both

A197/A197M-2019Standard Specification for Cupola Malleable
Iron

- A216/A216M-2018Standard Specification for Steel Castings,
Carbon, Suitable for Fusion Welding, For High-
Temperature Service
- A234/A234M-2018aStandard Specification for Piping Fittings of
Wrought Carbon Steel and Alloy Steel for
Moderate and High Temperature Service
- A269/A269M-2019Standard Specification for Seamless and Welded
Austenitic Stainless-Steel Tubing for General
Service
- A395/A395M-R2018Standard Specification for Ferritic Ductile
Iron Pressure-Retaining Castings for Use at
Elevated Temperatures
- B62-2017Standard Specification for Composition Bronze
or Ounce Metal Castings
- B88-2016Standard Specification for Seamless Copper
Water Tube
- E. American Welding Society (AWS):
- B2.1/B2.1M-2014Specification for Welding Procedure and
Performance Qualification
- Z49.1-2012Safety in Welding and Cutting and Allied
Processes
- F. California Referenced Standards Codes (CRSC):
- Title 24 Part 12-2016
- G. Manufacturers Standardization Society of the Valve and Fittings
Industry (MSS):
- SP-45-2014Bypass and Drain Connections
- SP-58-2018Pipe Hangers and Supports - Materials, Design,
Manufacture, Selection, Application, and
Installation
- SP-80-2013Bronze Gate, Globe, Angle and Check Valves
- SP-97-2019Integrally Reinforced Forged Branch Outlet
Fittings - Socket Welding, Threaded, and
Buttwelding Ends
- SP-127-2014aBracing for Piping Systems: Seismic - Wind -
Dynamic Design, Selection, and Application

- H. National Fire Protection Association (NFPA):
 - 30-2019Flammable and Combustible Liquids Code
 - 31-2019Standard for the Installation of Oil-Burning
Equipment
 - 54-2019National Fuel Gas Code
 - 85-2019Boiler and Combustion Systems Hazards Code
- I. Pipe Fabrication Institute (PFI):
 - ES24-2016Pipe Bending Methods, Tolerances, Process and
Material Requirements

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 21 11, BOILER PLANT PIPING SYSTEMS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Piping:
 - a. ASTM material specification number.
 - b. Grade, class or type, schedule number.
 - c. Manufacturer.
 - d. Intended service.
 - 2. Pipe Fittings, Unions, Flanges:
 - a. ASTM material specification number.
 - b. ASME standards number.
 - c. Catalog cuts.
 - d. Pressure and temperature ratings.
 - e. Intended service.
 - 3. Valves - Gate, Globe, Check, Plug, Butterfly, Ball:
 - a. Catalog cuts showing design and construction.
 - b. Pressure and temperature ratings.
 - c. Materials of construction.
 - d. Accessories.

- e. Intended service.
4. Sight Flow Indicators:
 - a. Catalog cuts showing design and construction.
 - b. Pressure and temperature ratings.
 - c. Materials of construction.
 - d. Intended service.
 5. Quick - Couple Hose Connectors and Steam Hose:
 - a. Catalog cuts showing design and construction.
 - b. Pressure and temperature ratings.
 - c. Materials of construction.
 - d. Type of seal between couplings.
 - e. Flexibility of steam hose.
 6. Pressure Reducing and Regulating Valves, Back Pressure Relief Valves, Safety Valves, Relief Valves:
 - a. Catalog cuts showing design and construction.
 - b. Service limitations (type of fluid, maximum pressure and temperatures).
 - c. Materials of construction.
 - d. Flow capacity at required set pressure or differential pressure.
 - e. Predicted sound levels, at operating condition, for steam pressure reducing valves.
 7. Strainers:
 - a. Catalog cuts showing design and construction.
 - b. Pressure and temperature ratings.
 - c. Materials of construction.
 - d. Strainer basket or liner mesh size.
 - e. Pressure loss and flow rate data.
 - f. Intended service.
 8. Emergency Gas Safety Shutoff Valves:
 - a. Catalog cuts showing design and construction.
 - b. Maximum pressure rating.
 - c. Material of construction.
 - d. Pressure loss and flow rate data.
 9. Steam Traps:
 - a. Catalog cuts showing design and construction.
 - b. Service limitations (maximum pressures and temperatures).

- c. Materials of construction.
 - d. Flow rates at differential pressures shown on drawings.
 - e. Orifice size for each trap.
 - f. Monitoring equipment or attachments
10. Flexible Connectors:
- a. Catalog cuts showing design and construction.
 - b. Pressure and temperature ratings.
 - c. Materials of construction.
 - d. Maximum allowable lateral and axial movements.
 - e. Description of type of movement permitted, intermittent offset or continuous vibration.
 - f. Intended service.
11. Pipe Support Systems: The contractor shall provide the following with submissions.
- a. Credentials of technical personnel who will design the support systems.
 - b. Description of computer program for pipe support selection indicating its capability and limitations. Provide documentation showing both program verification and validation results. List of projects where it was employed successfully.
 - c. Input and output data for pipe support selection program for all piping systems with pipe sizes 65 mm (2-1/2 inches) and above.
 - d. Boiler, feedwater deaerator and header manifold steam nozzle (pipe connection) allowable and actual forces and moments imposed by connecting piping.
 - e. Hanger load calculation methods and results for piping systems with pipe sizes 50 mm (2 inches) and below.
 - f. Piping layouts showing location and type of each hanger support and anchors with unique identifiers that can be referenced back to the calculation results.
 - g. Catalog cuts showing design and construction of each hanger support and anchor and their conformance to MSS standards.
 - h. Drawings showing arrangement and sizes of all components comprising each spring-type hanger and support assembly.
 - i. Load rating and movement tables for all spring hangers.

- j. Stress analyses on the boiler plant piping systems under all possible load conditions as part of the design. Once all piping is completed another stress analysis is required on the as built systems. Documentation results shall flag locations/components requiring recommended revision/modification to obtain acceptable stress levels.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Entire installation shall comply with ASME B31.1 and appendices and NFPA 54.
- B. Boiler External Piping, as defined in the ASME BPVC Section I, is required to be constructed and inspected in conformance with the ASME Code.
- C. The products and execution of work specified in this section shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.
- D. Welding Qualifications: 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 BPVC Section IX, AWS Z49.1 and AWS B2.1/B2.1M.
 2. Comply with provisions in ASME B31.1.
 3. Certify that each welder and welding operator has passed AWS qualification tests for welding processes involved and that certification is current and recent. Submit documentation to the COR.
 4. All welds shall be stamped according to the provisions of the American Welding Society.
- E. ASME Compliance: Comply with ASME B31.1 for materials, products, and installation. Safety valves and pressure vessels shall bear appropriate ASME labels.

1.6 DELIVERY, STORAGE AND HANDLING

- A. All piping shall be stored and kept free of foreign material and shall be internally and externally cleaned of all oil, dirt, rust and foreign material. Deliver and store valves and pipe hangers in sealed shipping containers with labeling in place. Storage must be in dry, protected location.

1.7 INFORMATION ON PRESSURE-TEMPERATURE DESIGN OF PIPING SYSTEMS

- A. Steam service pressures are selected to provide optimum pressure to the facilities served by the boiler plant. Main steam header pressure shall be controlled at 110 psig. Maximum pressure capability of steam systems between boilers and through first pressure reducing valve protected by a safety valve shall be governed by the pressure/temperature relationship of the highest safety valve setting shown for the boilers.
- B. Steam distribution systems protected by safety valves following pressure reducing stations or protected by safety valves on the boilers shall be governed by the pressure/temperature relationship developed by the maximum setting of the safety valve on that system.
- C. Boiler feedwater systems between boiler feed pumps, economizers (if provided), and boilers are designed for a normal maximum temperature of 138 degrees C (280 degrees F), and emergency temperature of 213 degrees C (415 degrees F) (if economizers are provided and economizer safety relief valve setting is 1896 kPa (275 psig)). Design pressure is the greater of: boiler feed pump shut off head; or 1896 kPa (275 psig) set pressure, plus accumulation, of economizer (if provided) relief valve.

- D. Condensate collection and transfer systems to suction of boiler feed pumps are designed for maximum temperatures to 100 degrees C (212 degrees F), and pressures 276 kPa (40 psig). Vacuum return systems shall operate between 0 and 27 kPa (0 and 8-inch Hg) vacuum and equivalent steam saturation temperatures.
- E. Natural gas fuel systems are designed, and materials and equipment are applied to prevent failure under gas pressure of 10 psig entering Government property. LP gas systems for emergency use are designed for maximum LP tank pressure of 1724 kPa (250 psig).
- F. Water service pressures are 250 psig maximum. Systems are designed to operate under conditions of maximum available pressure.
- G. Drips, drains, blowdown, water sampling, and chemical treatment are designed, and materials and equipment are applied in accordance with the maximum pressure and temperature of the system with which they are associated.
- H. Low pressure steam, condensate, vacuum and vents are designed for service pressures and temperatures equivalent to 103 kPa (15 psig) saturated steam.
- I. Compressed air systems are designed to accommodate a maximum pressure of 861 kPa (125 psig).
- J. Instrumentation and control piping shall be provided for the service and pressure characteristics of the systems to which they are connected.

1.8 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

PART 2 - PRODUCTS

2.1 STEAM PIPING

- A. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or electric resistance welded (ERW). Schedule 40 for piping up

to 861 kPa (125 psig) with welded ends. Schedule 80 for piping with threaded ends and piping over 861 kPa (125 psig) with welded ends.

B. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded, no other types allowed.
2. Pipe sizes 50 mm (2 inches) and below: Threaded, butt-welded, or socket-welded. Use Schedule 80 pipe and fittings for threaded joints.

C. Fittings:

1. Welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius.
2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class. Use Schedule 80 pipe and fittings for threaded joints.
3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.

D. Unions on Threaded Piping: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class on piping 50 mm (2 inches) and under.

E. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105/A105M, 1034 kPa (150 psig) pressure class, except 2070 kPa (300 psig) class required adjacent to 1724 kPa (250 psig) and 2070 kPa (300 psig) class valves. Bolts shall be high strength steel ASTM A193/A193M, Class 2, Grade B7. Nuts shall be ASTM A194/A194M.

2.2 STEAM CONDENSATE PIPING

A. Includes all gravity, drip return, pumped and vacuum systems. Does not include piping system between boiler feed pumps and boilers.

B. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW, Schedule 80.

C. Joints:

1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded, no other types allowed.
2. Pipe sizes 50 mm (2 inches) and below: Schedule 80 threaded, butt-welded or socket-welded.

D. Fittings:

1. Welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.

2. Threaded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class. Use Schedule 80 pipe and fittings for threaded joints.
 3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
- E. Unions on Threaded Piping: For piping 50 mm (2 inches) and under, forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class. Use Schedule 80 pipe and fittings for threaded joints.
- F. Flanges: Forged steel weld neck, ASTM A105/A105M, ASME B16.5, 1034 kPa (150 psig).

2.3 FUEL PIPING

- A. Natural gas, LP gas (propane) for main burner and igniter (pilot) fuels, gas vent piping. Comply with ASME B31.1 and NFPA 54.
- B. Piping: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW, Schedule 40.
- C. Joints:
1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded, no other types allowed.
 2. Pipe sizes 50 mm (2 inches) and below: Socket-welded or butt-welded.
- D. Fittings:
1. Butt-welded joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.
 2. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
- E. Unions on piping 50 mm (2 inches) and under: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class.
- F. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105/A105M, 1034 kPa (150 psig).
- G. Companion flanges: Flanges and bolting shall conform to ASME B16.5.
- H. Burner Piping: Furnished as part of the factory-assembled burners may be manufacturer's standard materials and assembly. Comply with ASME B31.1, for the actual operating conditions.
- I. Igniter (Pilot) Piping: Furnished as part of the factory assembled burners may have 2070 kPa (300 psig) ASTM A47/A47M, ASME B16.3 malleable iron threaded fittings in lieu of welded steel. If threaded fittings are provided, piping shall be Schedule 80.

2.4 BOILER FEEDWATER PIPING

- A. Piping from boiler feedwater pump discharge to inlet of boilers.
- B. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW. Piping with threaded joints shall be Schedule 80; welded joints Schedule 40. No joining of different schedule pipe in order to have welded on one end and threaded on the other. In these cases, the length of pipe shall be Schedule 80.
- C. Joints:
 - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded, no other types are allowed.
 - 2. Pipe sizes 50 mm (two inches) and below: Threaded, butt-welded, or socket-welded.
 - 3. No pipe to pipe joints when the length of the run is less than a full length of pipe.
- D. Fittings:
 - 1. Butt-welded Joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - 2. Threaded Joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class. Use Schedule 80 pipe and fittings for threaded joints.
 - 3. Socket-welded joints: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
- E. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class.
- F. Flanges and Bolts: Forged steel weld neck, ASME B16.5, ASTM A105/A105M, 2070 kPa (300 psig) pressure class. Bolts shall be High strength ASTM A193/A193M, Class 2, Grade B7. Nuts shall be ASTM A194/A194M.

2.5 BOILER BLOWOFF PIPING

- A. From boiler bottom blowoff connection to blowoff tank. Connections between boiler accessories drain valves and blowoff lines.
- B. Pipe: Carbon steel, ASTM A106/A106M, Grade B, seamless, Schedule 80.
- C. Joints: Butt-welded, no other types are allowed.
- D. Fittings: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe, all elbows long radius. Tees or crosses are prohibited.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105/A105M, 2070 kPa (300 psig).

- F. At no point shall the bottom blow down lines rise above the point of connection to the boiler.

2.6 DRAIN PIPING FROM BOILER ACCESSORIES TO DRAIN VALVE

- A. Drain piping from water column, low water cutoffs, gauge glass, water level sensor, remote water level devices (where applied).
- B. Pipe: Carbon steel, ASTM A106/A106M, seamless, Schedule 40.
- C. Joints: Threaded.
- D. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.
- E. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class.

2.7 VENT LINES FROM TANKS AND SAFETY AND RELIEF VALVES

- A. Pipe: Carbon steel, ASTM A53/A53M Grade B or A106/A106M Grade B, seamless or ERW, Schedule 40.
- B. Joints:
 - 1. Pipe sizes 65 mm (2-1/2 inches) and above: Butt-welded, no other types are allowed.
 - 2. Pipe sizes 50 mm (2 inches) and below: Threaded or butt-welded.
- C. Fittings:
 - 1. Welded Joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, same schedule as adjoining pipe.
 - 2. Threaded Joints: Steel, ASTM A234/A234M, Grade B, ASME B16.9, Schedule 80.
- D. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class.
- E. Flanges: Forged steel weld neck, ASME B16.5, ASTM A105/A105M, 1034 kPa (150 psig).

2.8 COLD WATER PIPING

- A. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- B. City Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- C. All copper pipe shall use only soldered fittings.

2.9 REVERSE OSMOSIS WATER PIPING (NOT USED)

2.10 COMPRESSED AIR PIPING

- A. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW Schedule 40.
- B. Joints: Threaded.

C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psig class); or malleable iron ASTM A47/A47M or ASTM A197/A197M, ASME B16.3, 1034 kPa (150 psig) class.

D. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class; or malleable iron, 1034 kPa (150 psig) class.

2.11 BOILER WATER SAMPLING, CONTINUOUS BLOWDOWN

A. Pipe: Steel, ASTM A106/A106M Grade B, seamless, Schedule 80.

B. Joints: Threaded.

C. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class.

Fittings between boiler and first stop valve must be forged steel, ASME B16.11, 13,790 kPa (2000 psig) or 20,685 kPa (3000 psig) class.

D. Unions: Malleable iron, 2070 kPa (300 psig) class.

2.12 FEEDWATER SAMPLING AND CHEMICAL FEED PIPING

A. Pipe: Stainless steel tubing, ASTM A269/A269M, Type 316.

B. Fittings: Stainless steel Type 316 welding fittings.

2.13 MISCELLANEOUS PIPING

A. Instrument and Control Piping (Sensing Point to Transmitter, Controller, or Other Instrument): Construction shall be same as specified for main service.

B. Drain Piping (All Drain Piping Discharging to Floor Drain-From Drain Valve to Floor Drain):

1. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW, Schedule 40.

2. Fittings and Unions: Forged steel, ASME B16.11, 13,790 kPa (2000 psig class); or malleable iron, 1034 kPa (150 psig), threaded.

C. Pump Recirculation:

1. Pipe: Carbon steel, ASTM A53/A53M Grade B or ASTM A106/A106M Grade B, seamless or ERW, double extra strong. Schedule 40 permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.

2. Joints: Threaded.

3. Fittings: Forged steel, ASME B16.11, 13,790 kPa (2000 psig) class; or malleable iron, ASTM A47/A47M or ASTM A197/A197M, ASME B16.3, 2070 kPa (300 psig) class, except 1034 kPa (150 psig) class permitted on all lines 1500 mm (5 feet) or more from the recirculation orifice.

4. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class; or malleable iron, ASTM A47/A47M or ASTM A197/A197M, same pressure class as nearest fittings.

2.14 DIELECTRIC FITTINGS

- A. Provide threaded dielectric unions for pipe sizes 50 mm (2 inches) and under. For 65 mm (2-1/2 inches) and above, provide steel flanges electrically isolated at gasket and by sleeves at bolts. Fittings on cold water and soft water lines shall be rated for 690 kPa (100 psig), 27 degrees C (80 degrees F). Fittings on steam condensate lines shall be rated at 520 kPa (75 psig), 121 degrees C (250 degrees F). Fittings on other services shall be rated for the maximum pressure and temperature conditions of the service.

2.15 VALVES; GATE, GLOBE, PLUG, CHECK, BALL, BUTTERFLY, VENT COCKS

- A. Valves for particular services are generally specified as Type Numbers. The Type Numbers are defined below. All valves of the same type shall be the products of a single manufacturer. Comply with MSS SP-45, MSS SP-80, and ASME B31.1. Design valves for the service fluids and conditions. Pressure-temperature ratings listed are minimum requirements. Packing and gaskets shall not contain asbestos.
- B. Valve Type Designations:
1. Gate Valves:
 - a. Type 101: Cast steel body ASTM A216/A216M WCB, rated for 1034 kPa at 260 degrees C (150 psig at 500 degrees F), 11.5 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1034 kPa (150 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet.
 - 1) Provide factory installed globe-valved warm-up bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6.1 m (20 feet). Conform to MSS SP-45.
 - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
 - b. Type 102: Cast steel body ASTM A216/A216M WCB, Class 300, 11.5 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) alloy seats, ASME flanged ends, OS&Y, rising stem, and bolted bonnet.

- 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6.1 m (20 feet). Conform to MSS SP-45.
 - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
 - c. Type 103: Cast steel body ASTM A216/A216M WCB, Class 300, 11.5 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) alloy seats, ASME flanged ends, OS&Y, rising stem, and bolted bonnet.
 - 1) Provide factory installed globe-valved bypass when main valve is 75 mm (3 inch) pipe size or greater and serves steam main longer than 6.1 m (20 feet). Conform to MSS SP-45.
 - 2) Drill and tap bosses for connection of drains if valve is in steam service. Conform to MSS SP-45.
 - d. Type 105: Forged steel body ASTM A105/A105M, rated for 2070 kPa at 216 degrees C (300 psig at 420 degrees F) minimum, Class 4138 kPa (600 psig) or Class 5515 kPa (800 psig), hardened stainless steel or stellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.
2. Globe Valves:
- a. Type 201: Cast steel body ASTM A216/A216M WCB, rated for 1034 kPa at 260 degrees C (150 psig at 500 degrees F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1034 kPa (150 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains where shown. Conform to MSS SP-45.
 - b. Type 205: Forged steel body ASTM A105/A105M, rated for 2070 kPa at 216 degrees C (300 psig at 420 degrees F) minimum, Class 4138 kPa (600 psig) or Class 5515 kPa (800 psig), stainless steel disc, stellite seat, threaded ends, OS&Y, rising stem, bolted bonnet.
3. Plug Valves: Cast steel body ASME B16.5 Class 150, one-fourth turn to open. 861 kPa (125 psig) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. All components designed for service to which applied: natural

gas, LP gas (propane), or fuel oil. Furnish lever handle for each valve.

- a. Type 301: Two-way valves up through 100 mm (4 inches) pipe size. Eccentric action, non-lubricated plug with resilient seal molded into groove on plug face providing bubble-tight shut off. O-ring stem seal, corrosion-resistant bearings, corrosion-resistant seat coating, seal materials as recommended by valve manufacturer for the service. Valves on natural gas service AGA approved.
- b. Type 302: Two-way valves 125 mm (5 inches) pipe size and above, all sizes of three-way valves. Lubricated full-port plug type with lubricant for intended service. Reinforced Teflon stem seal, valve plug floated on Teflon surfaces, lubricant injection system that has sufficient pressure to fully lubricate all sealing surfaces. Provide laminated plastic label attached to each valve stating, "Lubricate with //(Insert appropriate description)// once a year".

4. Check Valves:

- a. Type 401: Not used.
- b. Type 402: Swing-type, cast steel body ASME B16.34, rated for 1724 kPa (250 psig) saturated steam, 3447 kPa (500 psig) WOG, bronze or bronze-faced disc and seat, 1724 kPa (250 psig) ASME flanged ends, bolted cover, renewable disc and seat.
- c. Type 403: Swing-type, cast steel body ASME B16.34, rated for 861 kPa (125 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze-faced disc and seat, 861 kPa (125 psig) ASME flanged ends, bolted cover, renewable disc and seat.
- d. Type 405: Lift-type, forged steel body ASTM A105/A105M, rated for 2070 kPa at 216 degrees C (300 psig at 420 degrees F) minimum (Class 4138 kPa (600 psig) or 5515 kPa (800 psig)), hardened stainless steel disc, hard faced seat, bolted cover, threaded ends.
- e. Type 406: Swing-type, Type 316 stainless steel body, disc and hanger, rated for 1724 kPa at 182 degrees C (250 psig at 360 degrees F) minimum.

- f. Type 408: Silent spring-loaded wafer type, cast steel ASTM A216/A216M WCB body, rated for 2070 kPa (300 psig) water, 121 degrees C (250 degrees F), stainless steel trim.
5. Ball Valves: Reduced port permitted for bypass (throttling) service; full port required for all other services, one-fourth turn to open.
- a. Type 501: Type 316 stainless steel body, ball and stem, rated for 1034 kPa at 185 degrees C (150 psig at 365 degrees F), 4138 kPa at 93 degrees C (600 psig at 200 degrees F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends.
 - b. Type 502: Steel body, rated for 1034 kPa at 185 degrees C (150 psig at 365 degrees F), 1724 kPa at 121 degrees C (250 psig at 250 degrees F), reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.
 - c. Type 503: Carbon steel body, steam service, rated for 1380 kPa at 200 degrees C (200 psig at 392 degrees F), stainless steel ball and stem, Polyfil seat, live-loaded or adjustable stem seal, threaded ends.
 - d. Type 504: Carbon steel body, saturated steam service, rated for 1034 kPa (150 psig), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, ASME flanged ends.
6. Butterfly Valves:
- a. Type 601: Carbon steel ASTM A216/A216M wafer style, rated for 861 kPa at 121 degrees C (125 psig at 250 degrees F), bronze disc, stainless steel stem, EPDM liner, EPDM stem seal and body seal, neck extending beyond pipe insulation, lever operator.
 - b. Type 602: Carbon steel body, triple-offset design, lug or flanged type, rated for steam service at 1034 kPa at 260 degrees C (150 psig at 500 degrees F), stainless steel nitrided disc, stainless steel seat, stainless steel shaft, stainless steel/graphite laminated seal ring, neck extending beyond pipe insulation, geared handwheel operator for valves 100 mm (4 inch) pipe size and over, lever operator for valves 75 mm (3 inch) pipe size and under.

7. Gas Vent Cocks: Type 701, bronze body, tee handle, rated for 207 kPa at 38 degrees C (30 psig at 100 degrees F), ground plug, rated for tight shut-off on fuel gas service.

C. Boiler Valves:

1. Steam Non-Return Stop Check Valves:

- a. Type: Straight-way Y-pattern, with dash-pot and piston and tapped drain openings, OS&Y, bolted bonnet, rising stem. Provide angle pattern only if shown on the contract drawings.
- b. Construction: Cast steel body ASTM A216/A216M WCB, rated for 2070 kPa (300 psig) saturated steam, stellite faced steel disc, alloy steel seat, 2070 kPa (300 psig) ASME flanged ends.
- c. Operation: Valves shall automatically close tightly when boiler steam pressure becomes less than that of the steam header. Valves shall operate without sticking or chattering.

2. Stop Valves for Steam Vents on Boiler Drums and Steam Lead, Steam Pressure Gauge:

- a. Installation of steam pressure gauge shut-off valves shall conform to ASME BPVC, Section I.
- b. Angle stop valves (water tube boilers), OS&Y, chain operated, cast or forged steel, 1380 kPa (200 psig) steam rating, renewable seat and disc.
- c. Gate valves, two inches and under: Type 105.

3. Valves in Drain Lines from Steam Stop Check Valve, Water Column, Gauge Glass, Low Water Cut-offs:

- a. Gate valves, two inches and under: Type 105.
- b. Check valves, two inches and under: Type 405.

4. Bottom Blowoff Valves:

- a. Type: Seatless, sliding plunger, OS&Y, designed for blowoff service. Sliding disc-type or globe-type valves are prohibited.
- b. Construction: ASTM A216/A216M WCB cast steel body, rated for 2070 kPa (300 psig) saturated steam, 2070 kPa (300 psig) ANSI flanged ends. Valves shall have handwheel with rotating handle.
- c. Conform to ASME B31.1.

D. Steam above 103 kPa (15 psig), all valves in steam pressure reducing stations:

1. Gate valves, 50 mm (2 inches) and under: Type 105.

2. Gate valves, 65 mm (2-1/2 inches) and above: Type 101.
 3. Globe valves, 50 mm (2 inches) and under: Type 205.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 201.
 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
 6. Ball valves, 50 mm (2 inches) and under: Type 503.
 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- E. Steam 103 kPa (15 psig) and under:
1. Gate Valves, 50 mm (2 inches) and under: Type 105.
 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
 3. Globe valves, 50 mm (2 inches) and under: Type 205.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 205.
 5. Butterfly valves, 75 mm (3 inches) and above: Type 602.
 6. Ball valves, 50 mm (2 inches) and under: Type 503.
 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
- F. Boiler Feedwater from Pumps to Boilers, Recirculation:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 102.
 3. Globe valves, 50 mm (2 inches) and under: Type 205.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 205.
 5. Check valves, at boiler feed pump discharge: Type 408.
 6. Check valves, at boiler, 50 mm (2 inches) and under: Type 405.
 7. Check valves, at boiler, 65 mm (2-1/2 inches) and above: Type 402.
- G. Condensate, Condensate Transfer, Boiler Feedwater from Feedwater Deaerator to Boiler Feed Pump Suction, Overflow, Control and Instrument Piping for Condensate Storage Tank and for Feedwater Deaerator:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
 2. Gate valves, 65 mm (2-1/2 inches) and above: Type 103.
 3. Globe valves, 50 mm (2 inches) and under: Type 205.
 4. Globe valves, 65 mm (2-1/2 inches) and above: Type 205.
 5. Butterfly valves, 65 mm (2-1/2 inches) and above Type 601.
 6. Ball valves, 50 mm (2 inches) and under: Type 502.
 7. Ball valves, 65 mm (2-1/2 inches) and above: Type 504.
 8. Check valves 50 mm (2 inches) and under: Type 405.
 9. Check valves, 65 mm (2-1/2) inches and above: Type 403.
 10. Check valves on pump discharge, all sizes: Type 408.

- H. Boiler Water Sampling, Continuous Blowdown:
1. Gate Valves, 50 mm (2 inches) and under: Type 105.
 2. Globe valves, 50 mm (2 inches) and under: Type 205.
 3. Check valves, 50 mm (2 inches) and under: Type 405.
 4. Ball valves, 50 mm (2 inches) and under: Type 502.
 5. Continuous Blowdown Flow Control Valve: Forged steel angle-type body, rated for 2070 kPa at 288 degrees C (300 psig at 550 degrees F), hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, graduated micrometer-type dial and pointer showing amount of valve opening. Furnish valve blowdown chart showing flow rate versus valve opening based on 861 kPa (125 psig) boiler drum pressure.
- I. Feedwater Sampling:
1. Ball valves, 50 mm (2 inches) and under: Type 501.
 2. Check valves, 50 mm (2 inches) and under: Type 406.
- J. Chemical Feed System:
1. Ball valves, 50 mm (2 inches) and under: Type 501.
 2. Check valves, 50 mm (2 inches) and under: Type 406.
- K. Fuel Gas: Main fuel and igniter (pilot) systems.
1. Plug valves, 100 mm (4 inches) and under: Type 301.
 2. Ball valves, 50 mm (2 inches) and under: Type 502. May be applied where plug valves are shown.
 3. Plug valves, 125 mm (5 inches) and above: Type 302.
 4. Plug valves, three-way, all sizes: Type 302.
 5. Check valves, 50 mm (2 inches) and under: Type 405.
 6. Vent cocks, 15 mm (1/2 inch) and under: Type 701.
- L. Compressed Air:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
 2. Ball valves, 50 mm (2 inches) and under: Type 502.
- M. City (Cold) Water: See Section 22 11 00, FACILITY WATER DISTRIBUTION.
- N. Soft Water: See Section 22 31 11, WATER SOFTENERS.
- O. Instrumentation and Control Piping: Ball valves, 50 mm (2 inches) and under: Type 502.
- P. Non-Boiler Blowdowns, Drains, Flow Sensing Lines:
1. Gate valves, 50 mm (2 inches) and under: Type 105.
 2. Ball valves, 50 mm (2 inches) and under: Type 503.

2.16 GAUGES, PRESSURE AND COMPOUND

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide steel, lever handle union cock. Provide steel or stainless-steel pressure snubber for gauges in water service. Provide steel pigtail syphon for steam gauges.
- C. Pressure gauge ranges shall be selected such that the normal operating pressure for each gauge is displayed near the midpoint of each gauge's range. Gauges with ranges selected such that the normal pressure is displayed at less than 30 percent or more than 70 percent of the gauge's range are prohibited. The units of pressure shall be psig.

2.17 SIGHT FLOW INDICATORS

- A. Provide, where shown, to allow observation of flow in piping systems.
- B. Type: In line, dual portholes on opposite sides, with safety shield, with or without rotor as shown on the drawings. Where provided, rotor shall have minimum of three vanes.
- C. Construction: Carbon steel body, tempered borosilicate window, PTFE seals (except Buna-N on oil service), threaded ends on pipe sizes under 65 mm (2-1/2 inches), flanged ends on sizes 65 mm (2-1/2 inches) and above. Pressure and temperature ratings shall be equivalent to requirements for valves on the same pipelines.
- D. Safety Shield: Transparent wrap-around overlap covering entire sight flow indicator, designed to protect personnel from failure of indicator. Shield shall fit the indicator tightly and be suitable for 1034 kPa, 150 degrees C (150 psig, 302 degrees F).

2.18 QUICK-COUPLE HOSE CONNECTORS AND STEAM HOSES

- A. Provide on all Y-strainer drains and where shown to allow quick connection of length of hose to piping drain or blowoff so that discharge fluid (water or steam) can be conveyed to a drainage system.
- B. Type: Straight through, plug and socket, screw type or cam locking connections, all units 20 mm (3/4 inch) pipe size. Integral shut-off devices not required.

- C. Service: Design for water and steam at 103 kPa (15 psig), 154 degrees C (309 degrees F).
- D. Spare Parts: Furnish one socket and one plug.
- E. Accessories: Furnish two hoses 6.1 m (20 feet) long, 20 mm (3/4 inch) inside diameter, rated for steam service at 690 kPa, 149 degrees C (100 psig, 300 degrees F). Hose must be sufficiently flexible to be placed in 1200 mm (4 foot) diameter coil. Provide connector on one end of each hose to mate with connectors on drains. Provide hose rack for holding both hoses. Securely mount rack in location selected by COR.

2.19 SAFETY VALVES, RELIEF VALVES, SAFETY RELIEF VALVES AND ACCESSORIES

- A. Provide valves and accessories to protect piping systems and pressure vessels from over-pressure. All valves shall comply with ASME BPVC Section I and ASME BPVC Section VIII). Flow capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors (NB).
- B. Boiler and Economizer Service: Refer to Section 23 52 39, FIRE-TUBE BOILERS.
- C. Steam Service (Pressure Vessels and Piping Systems): Refer to schedules on drawings for set pressures and capacities. Provide lifting levers, stainless steel trim, lapped seats on steel valves.
- D. Compressed Air Service: Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- E. Drip Pan Ells: Cast iron factory-built safety valve discharge fitting with pipe-within-pipe slip-type connection to vertical vent pipe, basin for collecting condensate from vent pipe, drain connections on basin and at base of ell.

2.20 STEAM PRESSURE REDUCING VALVES

2.21 STRAINERS, SIMPLEX BASKET TYPE

- A. Provide on condensate lines where shown. Refer to Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT, for duplex basket strainers at oil pumps.
- B. Type: Simplex cylindrical basket type, clamp cover, closed-bottom, removable basket, drain at bottom with threaded plug.
- C. Service: Water at 100 degrees C (212 degrees F), 103 kPa (15 psig) maximum pressure.

D. Construction:

1. Body: Cast steel rated for 861 kPa (125 psig) ASME flanged ends, flow arrows cast on side.
2. Basket: Stainless steel, 3.2 mm (1/8 inch) perforations. Ratio of screen open area to cross section of pipe; four to one minimum.

2.22 STRAINERS, Y-TYPE

A. Provide as shown on steam, water and compressed air piping systems.

B. Type: Open-end removable cylindrical screen. Threaded blow-off connection.

C. Construction:

1. Steam Service 420 to 1034 kPa (61 to 150 psig): Cast steel rated for 1034 kPa (150 psig) saturated steam with 1034 kPa (150 psig) ASME flanged ends, or forged steel with 1724 kPa (250 psig) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast steel rated for saturated steam at 1034 kPa (150 psig) threaded ends, for pipe sizes 50 mm (2 inches) and under.
2. Steam Service 414 kPa (60 psig) and under, water (except boiler feed between feedwater pumps and boilers), compressed air: Cast steel rated for 861 kPa (125 psig) saturated steam, 1200 kPa (175 psig) WOG, with 861 kPa (125 psig) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast steel, threaded ends, rated for 861 kPa (125 psig) saturated steam, 1200 kPa (175 psig) WOG, for pipe sizes 50 mm (2 inches) and under.
3. Boiler Feed between Feedwater Pumps and Boilers: Cast steel rated for 1724 kPa at 232 degrees C (250 psig at 450 degrees F) with 2070 kPa (300 psig) ASME flanged ends, or cast steel with 1724 kPa (250 psig) ASME flanged ends, for pipe sizes above 50 mm (2 inches). Cast steel, threaded ends, rated for 1724 kPa at 232 degrees F (250 psig at 450 degrees F) for pipe sizes 50 mm (2 inches) and under.

D. Screen: Monel or stainless steel, free area not less than 2-1/2 times flow area of pipe. For strainers 75 mm (3 inch) pipe size and smaller, diameter of openings shall be 0.8 mm (0.032 inch) or less on steam service, 1.3 mm (0.05 inch) or less on water service, 0.3 mm (0.01 inch) or less on compressed air service. For strainers 100 mm (4 inch) pipe size and greater, diameter of openings shall be 1.3 mm (0.05 inch) on steam service, 3.2 mm (1/8 inch) on water service. Provide 80 mesh

stainless steel screen liner on all strainers installed upstream of water meters or control valves.

- E. Accessories: Gate or ball valve and quick-couple hose connection on all blowoff connections. These items are specified elsewhere in this section.

2.23 LIQUID PETROLEUM TANKS GAS PRESSURE REGULATORS

- A. Type: Single stage or two-stage designed to reduce tank pressure to LPG header pressure 34 kPa (5 psig). Outlet pressure shall be adjustable. Design for LPG (propane) service. Valve shall be weatherproof for outside installation. Valve body shall be designed for 1724 kPa (250 psig). Provide internal relief valve set at 69 kPa (10 psig).
- B. Performance: Valve shall provide steady outlet pressure of 34 kPa (5 psig) with flow rate required by igniters (pilots) furnished, with tank pressure variation from 1724 kPa to 138 kPa (250 psig to 20 psig).

2.24 EMERGENCY GAS SAFETY SHUT-OFF VALVE

- A. Permits remote shut-off of fuel gas flow to boiler plant.
- B. Type: Manually opened, electrically held open, automatic closing upon power interruption. Pneumatic operator is prohibited.
- C. Performance: Shall shut bubble tight within one second after power interruption. Refer to the drawings for pressure, flow, and valve size requirements.
- D. Service: Natural gas and LP gas.
- E. Construction: UL listed, FM approved, rated for 861 kPa (125 psig) ASME flanged ends for pipe sizes above 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and under. Cast iron, cast steel or bronze body, open and shut indicator. Valves for LP gas service shall be rated at 1724 kPa (250 psig).
- F. Control Switch: Mounted on Boiler Plant Instrumentation Panel. Switch shall also cut the power to the fuel oil pump set. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Provide auxiliary switch to operate annunciator on Boiler Plant Instrumentation Panel.

2.25 EARTHQUAKE AUTOMATIC GAS SHUT OFF VALVE (NOT USED)

2.26 STEAM TRAPS

- A. Application: Steam line drip points and heat exchangers. Each type furnished by a single manufacturer.

- B. Type: Inverted bucket type with thermostatic vent in bucket except closed float-thermostatic on discharge side of pressure reducing stations and on all heat exchangers. Refer to the drawings for trap locations, capacity and size, differential operating pressures, and design pressure.
- C. Trap bodies: Steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping. The use of raised face flange is required on pipe sizes 1½ inch and above. The use of unions is acceptable for pipe sizes below 1½ inches. For systems without relief valve traps shall be rated for the pressure upstream of the steam supplying the system.
- D. Floats: Stainless steel.
- E. Valves: Hardened chrome-steel.
- F. Mechanism and Thermostatic Elements: Stainless steel mechanisms. Bimetallic strip air vent on inverted bucket traps.
- G. Identification: Label each trap at the factory with an identification number keyed to number that is shown on the drawings. Label shall be a metal tag permanently affixed to the trap.
- H. Factory-Packaged Trap Station: As an option for drip points requiring isolating valves, strainer, trap, trap monitoring device or ports for future monitoring device, and valved test ports, provide factory-packaged trap station including these features.

2.27 PRESSURE DRIVEN CONDENSATE PUMP TRAP (NOT USED)

2.28 FLEXIBLE CONNECTORS

- A. Provide flexible connectors as shown to allow differential movements of pumps and piping systems subject to thermal expansion, to serve as vibration isolators between air compressors and piping systems, and to allow connection of steam or compressed air atomizing media for oil burners on water tube boilers.
- B. Units for Water Service:
 - 1. Service: Refer to schematic diagrams for pressure, temperature and movement requirements. If requirements are not shown on the drawings, units shall be designed for maximum system pressure, temperature, axial movement and lateral movement.

2. Construction:
 - a. Teflon Bellows Type: Molded Teflon bellows with metal reinforcing rings, flanged ends, bolted limit rods.
 - b. Stainless Steel Bellows Type: Multi-ply stainless steel with flanged ends, bolted limit rods.
 - c. Flexible Metal Hose Type: Corrugated stainless steel hose wrapped with wire braid sheath. Ends shall be threaded, with union connectors, for pipe sizes 50 mm (2 inches) and below, flanged for pipe sizes 65 mm (2-1/2 inches) and greater.
- C. Units for Compressed Air Service Only:
 1. Service: Designed for 93 degrees C (200 degrees F), 1034 kPa (150 psig), and 15 mm (1/2 inch) intermittent offset.
 2. Construction: Flexible corrugated stainless-steel hose wrapped with wire braid sheath. Provide threaded ends with union connectors.
- D. Units for Atomizing Media Service (Steam, Compressed Air) and Steam Safety Valve Drip Pan Ell Drains:
 1. Service: Designed for saturated steam at set pressure of boiler safety valves or for set pressure of compressor relief valve, whichever is greater. Hose shall be designed for bend radii to suit location of connection points to burner piping system. Hose shall also be designed for intermittent flexing.
 2. Construction: Flexible corrugated stainless-steel hose wrapped with wire braid sheath. Provide threaded ends with union connectors.

2.29 PIPING SUPPORT SYSTEMS

- A. Provide an engineered piping support system with all hangers, supports and anchors designed and located by experienced technical pipe support specialists, utilizing piping system design and analysis software. The system design must be completely documented and submitted for review.
- B. All pipe hangers and supports, and selection and installation shall comply with MSS SP-58 and MSS SP-127.
- C. All pipe hanger and support devices must be in compliance with specified MSS SP-58 type numbers, have published load ratings, and be products of engineered pipe support manufacturers.
- D. All pipe stresses and forces and moments on connecting equipment and structures shall be within the allowances of the ASME B31.1, applicable building codes, and equipment manufacturer's design limits.

- E. Piping that expands and contracts horizontally including steam, steam condensate, boiler feed, condensate transfer, shall be supported by roller or sliding type hangers and supports except when long vertical hanger rods permit sufficient horizontal movement with the vertical angles of the rods less than 4 degrees.
- F. Piping that expands and contracts vertically including steam, steam condensate, boiler feed, condensate transfer, shall be supported by engineered variable spring and spring cushion hangers. Utilize MSS SP-58 selection requirements and guidelines. Vibration isolator hanger types are prohibited.
- G. Piping system anchors shall be engineered and located to control movement of piping that is subject to thermal expansion.
- H. Prior to construction, submit complete engineering calculation methods and results, descriptions of all devices with MSS numbers, sizes, load capabilities and locations. Submit calculations on all moments and forces at anchors and guides, all hanger loads, all pipe stresses that are within 20 percent of the code allowable or exceed ASME B31.1 code allowable, all pipe movements at supports.
- I. Detailed Design Requirements:
 - 1. Piping system design and analysis software shall be current state of the art that performs ASME B31.1 code analyses, and shall be utilized to analyze pipe movement and deflection, pipe stresses, pipe support forces and moments, and for selection of pipe support types and sizes.
 - 2. Each support for piping 65 mm (2-1/2 inches) and above shall be completely engineered to include location, type and size, hot and cold loads and movement. Submit layout drawings showing precise support locations and submit individual drawings for each support assembly showing all components, sizes, loadings.
 - 3. Supports for piping 50 mm (2 inches) and below shall be engineered in general terms with approximate locations, typical support types and sizes, approximate movements. Submit layout drawings showing general locations and support types and sizes.
 - 4. Obtain permissible loadings (forces and moments) for equipment nozzles (pipe connections) from the manufacturer of the boilers, the feedwater deaerator and any other equipment as necessary.

Professional structural engineer shall verify capability of building structure to handle piping loads.

5. The project drawings may show locations and types of resilient supports including rollers and springs, and may also show special supports including anchors, guides and braces. Comply with the drawing requirements unless it is determined that piping may be overstressed or supports overloaded. Refer conflicts to the COR.
6. Variable spring hangers conforming the MSS SP-58, Type 51, shall support all piping that expands vertically from thermal effects which may include connected equipment, such as boilers. Spring rates must be selected to avoid excessive load transfer to the connected equipment as the piping expands vertically. Vibration-type spring isolators are not acceptable. Light duty spring hangers, MSS SP-58, Type 48, may be utilized on loads of 91 kg (200 pounds) or less, and vertical movement of 3.2 mm (1/8 inches) or less. Spring cushion hangers, MSS SP-58, Type 49, may be utilized for vertical movement of 3.2 mm (1/8 inches) or less.
7. Locate supports to permit removal of valves and strainers from pipelines without disturbing supports.
8. If equipment and piping arrangement differs from that shown on the drawings, support locations and types shall be revised at no cost or time to the Government. The Government will also require a complete stress analysis of the system as-built at no additional cost or time to the Government.

J. Hangers and Supports - Products:

1. Factory-built products of a manufacturer specializing in engineered pipe supports. All components must have published load ratings. All spring type supports shall have published spring rates and movement limits. All support assemblies shall include threaded connections that permit vertical position adjustment. Supports shall comply with MSS SP-58 Type Numbers as listed below.
2. Upper Attachments to Building Structure: Types 18, 20, 21, 22, 23, 29, and 30.
3. Roller Supports: Types 41, 43, and 46. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.

4. Variable Spring Hanger Assembly:
 - a. Type 51 variable spring, with Type 3 pipe clamp or Type 1 clevis. Type 53 variable spring trapeze may also be used. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
 - b. Typical features of variable spring hangers include spring rates under 150 lb/in, enclosed spring, load and travel indicator, sizes available with load capabilities ranging from 50 lb to multiples of 10,000 lb.
5. Spring Cushion Hanger Assembly: Double Rod: Type 41 and 49.
6. Light Duty Spring Hanger Assembly: Type 48 light duty spring, with Type 3 pipe clamp or Type 1 clevis. Locate Type 48 light duty spring within 300 mm (1 foot) above pipe attachment.
7. Clevis Hangers: Type 1.
8. Wall Brackets: Type 31, 32, and 33.
9. Pipe Stands: Type 38.
10. Riser Clamps: Type 42.
11. Roller Guides: Type 44. Construct guides to restrain movement perpendicular to the long axis of the piping. All members shall be welded steel.
12. Trapeze Supports: May be used where pipes are close together and parallel. Construct with structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with U-bolts.
13. Pipe Covering Protection Saddles: Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamp is provided. Insulation shields are prohibited. Refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
14. Sliding Supports: Type 35. Welded steel attachments to pipe and building structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
15. Piping Anchors: Provide engineered designs to accommodate the calculated loads.

2.30 PIPE AND VALVE FLANGE GASKETS

- A. Non-asbestos designed for the service conditions. On steam service utilize 3.2 mm (1/8 inch) thick Class 300 spiral-wound with Type 304 stainless steel and mica/graphite filler and carbon steel gauge ring.

2.31 THREAD SEALANTS

- A. As recommended by the sealant manufacturer for the service. Teflon tape of any type is prohibited on fuel oil systems.

2.32 PIPE SLEEVES

- A. Service: For pipes passing through floors, walls, partitions.
- B. Construction: Steel pipe, schedule 10 minimum.
- C. Sleeve Diameter: Not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe and thermal insulation, vapor barrier, and protective covering for insulated pipe; sleeves for un-insulated pipe shall be not less than 25 mm (1 inch) larger than the diameter of the enclosed pipe.

PART 3 - EXECUTION**3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 ARRANGEMENT OF PIPING

- A. The piping arrangement shown is a design based on currently available equipment. The plans show typical equipment to scale and show practical arrangement. Modification will be necessary during construction, at no additional cost or time to the Government, to adapt the equipment layout and piping plans to the precise equipment purchased by the Contractor. Accessibility for operation and maintenance must be maintained.
- B. All piping shall be installed parallel to walls and column centerlines (unless shown otherwise). Fully coordinate work of each trade to provide the designed systems without interference between systems. All piping shall be accurately cut, true, and beveled for welding. Threaded piping shall be accurately cut, reamed and threaded with sharp dies. Copper piping work shall be performed in accordance with best practices requiring accurately cut clean joints and soldering in accordance with

the recommended practices for the material and solder employed.

Compression type fittings are prohibited.

- C. All piping shall be pitched for drainage at a constant slope of 25 mm in 12 m (1 inch in 40 feet). Steam, condensate, trap discharge, drip, drain, air, gas and blowdown piping shall pitch down in direction of flow. Service water, pumped condensate, pumped boiler feedwater, oil, shall pitch up in direction of flow. Provide valved air vents at top of rise and valved drains at low points. Gas piping may be run level as it is presumed to be dry, but dirt pockets shall be provided at base of risers.
- D. Valves shall be located, and stems oriented to permit proper and easy operation and access to valve bonnet for maintenance of packing, seat and disc. Valve stems shall not be below centerline of pipe. Refer to plans for stem orientation. Where valves are more than 2.1 m (7 feet) above the floor or platform, stems shall be horizontal unless shown otherwise. Gate and globe valves more than 3 m (10 feet) above floor or platform, shall be accessed using additional permanent work platforms to be provided by contractor. Provide hammer-blow wheel on any valve that cannot be opened or tightly closed by one person. Steam line gate and butterfly type isolation valves 75 mm (3 inch) pipe size and above shall have factory or field-fabricated 20 mm or 25 mm (3/4 inch or 1 inch) globe-valved warm-up bypasses if the steam line length is 6.1 m (20 feet) or longer.
- E. Provide union adjacent to all threaded end valves.
- F. Bolt wafer-type butterfly valves between pipe flanges.
- G. Provide valves as necessary to permit maintenance of a device or sub-system without discontinuing service to other elements of that service or system.
- H. Do not install any piping within 600 mm (2 feet) of water tube boiler side or top casings.

3.3 WELDING

- A. The contractor is entirely responsible for the quality of the welding and shall:
 - 1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding

- operators have the ability to make sound welds under standard conditions.
2. Perform all welding operations required for construction and installation of the piping systems.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, AWS B2.1/B2.1M, AWS Z49.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the COR, to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.
- D. Examination Results: Provide the COR with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Provide approved welding method for joints on all pipes greater than 50 mm (2 inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (1 foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).
- H. Non-Destructive Examination of Piping Welds:
1. Perform radiographic examination of 50 percent of the first 10 welds made and 10 percent of all additional welds made. The COR reserves

- the right to identify individual welds for which the radiographic examination must be performed. All welds will be visually inspected by the COR. The VA reserves the right to require testing on additional welds up to 100 percent if more than 25 percent of the examined welds fail the inspection.
2. An approved independent testing firm regularly engaged in radiographic testing shall perform the radiographic examination of pipe joint welds. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.
 3. Comply with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project. The COR and the commissioning agent shall be given a copy of all reports to be maintained as part of the project records and shall review all inspection records.
 - I. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening are prohibited. Welders responsible for defective welds must be requalified prior to resuming work on the project.
 - J. Electrodes: Electrodes shall be stored in a dry heated area and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

3.4 PIPING JOINTS

- A. All butt-welded piping shall be welded at circumferential joints, flanges shall be weld neck type; slip-on flanges, screwed flanges may be applied only with written approval of the COR.
- B. Companion flanges at equipment or valves shall match flange construction of equipment or valve. Raised face shall be removed at all companion flanges when attached to flanges equipped for flat face construction.
- C. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

- D. Screw threads shall be made up with Teflon tape except gas and oil piping joints shall utilize specified joint compound.
- E. Solder joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping. The COR or their representative reserves the right to reject any soldered joints based on the appearance of excessive heat, solder build up or not evenly distributed around the joint, or excessive flux build up. In which case, the contractor shall remove, clean, and replace joints at no additional cost or time to the Government.

3.5 BRANCH INTERSECTION CONNECTIONS

- A. Factory-built reinforced tees and laterals are required.
- B. Factory-built integrally-reinforced forged steel branch outlet fittings may be used on reduced size connections upon approval of COR. They must comply with MSS SP-97.

3.6 EXPANSION AND FLEXIBILITY

- A. The design includes provision for piping expansion due to pressure, thermal, weight and seismic (where applicable) effects. It is the Contractor's responsibility to avoid reduction in flexibility and increase in stress in piping systems. Major deviation will be shown by submittal for review of scale working drawings and stress calculations for the piping systems. Contractor shall provide any necessary additional construction and materials to limit stresses to safe values as directed by the COR and at no additional cost or time to the Government.

3.7 PIPE BENDING

- A. Pipe bending shall be in accordance with the recommended practices of PFI ES24. Only ASTM A106/A106M seamless pipe may be bent. Sizes below 50 mm (2 inches) may be bent in field; sizes 65 mm (2-1/2 inches) and larger shall have factory-fabricated bends. Minimum radii and tangent lengths for field bent piping are shown in the following table:

Size	Minimum Radius	Minimum Tangent
15 mm (1/2 inch)	65 mm (2-1/2 inches)	40 mm (1-1/2 inches)
20 mm (3/4 inch)	70 mm (2-3/4 inches)	45 mm (1-3/4 inches)
25 mm (1 inch)	125 mm (5 inches)	50 mm (2 inches)
32 mm (1-1/4 inches)	159 mm (6-1/4 inches)	50 mm (2 inches)
40 mm (1-1/2 inches)	191 mm (7-1/2 inches)	65 mm (2-1/2 inches)

3.8 SIZE CHANGES

- A. Piping size changes shall be accomplished by use of line reducers, reducing ell, reducing tee. Apply eccentric reduction in all piping requiring continuous drainage; steam, condensate, vacuum, blowdown. Concentric reduction may be applied in run of piping involving pressure water systems except at pump inlets. Use concentric increasers where flow is in direction of increased size. Eccentric reduction, top flat, at all pump connections.

3.9 ADDITIONAL DRIPS AND TRAPS

- A. Where additional rises or drops in steam or gas lines are provided, provide additional drip pockets with steam trap assemblies on steam lines and additional dirt pockets on gas lines. All air drops shall have dirt legs and no actuator or other air operated equipment may come off the end of the air line. Airline taps are either from the top of the supplying line if the supply line is horizontal or from the side if the supplying line is vertical. All air operated equipment shall have inline moisture separators or dryers.

3.10 MINOR PIPING

- A. Minor piping associated with instrumentation and control is generally not shown. Interconnection of sensors, transducers, control devices, instrumentation panels, combustion control panel, burner control panels is the responsibility of the contractor. Small piping associated with water cooling, drips, drains and other minor piping may not be shown to avoid confusion in the plan presentation but shall be provided as part of contract work.

3.11 DIELECTRIC CONNECTION

- A. Where copper piping is connected to steel piping provide dielectric connections.

3.12 INSTALLATION - BOILER EXTERNAL STEAM PIPING FROM BOILER TO MAIN HEADER

- A. From Boiler to Second Stop Valve: Fabricate from boiler nozzle through second stop valve under the rules for boiler external piping of the ASME BPVC Section I. Full compliance will be required, including qualification of welders, Code inspection, and certification with ASME Form P4A. Deliver original of Form P4A properly executed to COR.

- B. Construction shall include: non-return stop and check valve at the boiler, welding coupling for 20 mm (3/4 inch) vent, second stop valve, steam flowmeter primary element, welding coupling for IPT calorimeter connection located to provide clear space and access for temporary test calorimeter, and header stop valve. Second stop valve may be deleted if the entire steam line from the non-return valve to the header valve is constructed in accordance with the rules for boiler external piping, ASME BPVC Section I.
- C. Companion flange at 2070 kPa (300 psig) valves shall be 2070 kPa (300 psig) weld neck; at 1034 kPa (150 psig) valves shall be 1034 kPa (150 psig) weld neck.
- D. Equip header stop valve with factory applied warm-up bypass connected to drilled and tapped bosses in valve body located above and below valve wedge. Connect valved drain to header valve body boss located above valve wedge.
- E. Equip steam pipe with 20 mm (3/4 inch) vent, 1380 kPa (200 psig) steel gate valve, as specified.
- F. Support and slope boiler steam line to drain; apply variable spring hangers (MSS-SP58, Type 51 or 53).
- G. Provide screwed fitting for calorimeter (temporary test instrument) on side of pipe as shown. Allow 600 mm (2 feet) horizontal and vertical clearance for calorimeter.
- H. Handwheel and drain valve on non-return stop check valve shall be within easy reach of boiler platform.
- I. Disassemble, clean and reassemble entire mechanism of non-return stop check valve after conclusion of boiler testing.

3.13 INSTALLATION - MAIN STEAM HEADER

- A. The header shall be the connection point for steam piping from all boilers and for steam distribution piping. The boiler plant steam pressure control transmitter shall be connected to the header.
- B. Steam header shall be assembly of tees, pipe sections, and weld neck flanges.
- C. Factory-fabricated forged steel integrally reinforced branch outlet welding fittings, standard weight, ASTM A105/A105M Grade 2, may be applied in lieu of tees for all branch outlets less than the full size

of the header. Comply with fitting manufacturer's recommendations and requirements of ASME B31.1 and MSS SP-97.

- D. Provide header supports and anchor as shown; apply insulation saddles for insulation thickness as required in Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- E. Weld neck flange bolt position shall conform to required valve, stem, and bypass orientation as shown.
- F. Header construction as specified includes the entire header and branches to first valve.
- G. Anchor and guide header to resist thermal and weight forces.
- H. All valves must be accessible without the use of ladders or chain-wheels.

3.14 INSTALLATION - BOILER BOTTOM BLOWOFF PIPING

- A. Fabricate with long swiping radius ells, Y-form laterals. Tees and crosses are prohibited.

3.15 INSTALLATION - EXHAUST HEAD MOUNTED ABOVE ROOF

- A. Provide drain line from connection on exhaust head to roof drain. Provide pipe size same as drain connection size.

3.16 INSTALLATION - SIGHT FLOW INDICATORS

- A. Locate to permit view from floor or platform.

3.17 INSTALLATION - PRESSURE AND TEMPERATURE REGULATORS, CONTROL VALVES, SAFETY SHUT-OFF VALVES

- A. Provide sufficient clearance on all sides of valve to permit replacement of working parts without removing valve from pipeline.
- B. Maintain access.

3.18 INSTALLATION - EMERGENCY GAS SAFETY SHUT-OFF VALVES

- A. Locate so that valve position indicator is visible from nearest walkway.
- B. Provide control wiring and wiring to annunciator on instrumentation panel and to computer workstation (if provided).
- C. Maintain access to the valve so that it can be easily maintained or reset.

3.19 INSTALLATION - FLEXIBLE CONNECTORS

- A. Install units for water and compressed air service in a straight run of pipe. Units for atomizing media service may be installed with bends if

necessary. Designer of atomizing media piping must coordinate hose connection points with allowable bend radius of hose.

3.20 INSTALLATION - SAFETY VALVES, RELIEF VALVES AND SAFETY-RELIEF VALVES

- A. Orient valves so that lifting levers are accessible from nearest walkway or access platform. Valves must be removable without requiring disassembling of vents, except where otherwise specifically provided.
- B. Provide a drip pan elbow at discharge of each steam or economizer valve with slip joint in vent discharge line, arranged to prevent vent line from imposing any force on valve and to prevent any moisture accumulation in valve. Connected drip pan ell drains to drain piping to floor drain. Provide flexible connector on drain line, adjacent to drip pan ell.
- C. Support vent line from above. Each steam valve must have separate vent line to atmosphere unless shown otherwise.
 - 1. Vent lines shall have no more than a total of 180 degrees of directional changes and any one change is limited to 45 degrees to limit back pressure. The COR may reject any vent based on back pressure and blow by during testing.
 - 2. Use stainless steel Schedule 40 piping for horizontal sections of vent piping. Use dielectric unions or flange gaskets at each dissimilar material vent joint.
- D. Relief valves in steam piping shall have a manual valve downstream of the relief valve to allow for testing of the valve in place without risk of over pressurizing downstream equipment.

3.21 INSTALLATION - Y-TYPE STRAINERS ON STEAM SERVICE

- A. Install with basket level with the steam pipe so that condensate is not trapped in the strainer.

3.22 INSTALLATION - QUICK COUPLE HOSE CONNECTORS

- A. Install male plugs on each piping drain. Connect socket to one end of steam hose.

3.23 INSTALLATION - VIBRATION ISOLATORS IN PIPING

- A. Install on all air lines and water supply lines to air compressors.
- B. Also install on pump connections as shown.

3.24 INSTALLATION - PIPE SLEEVES

- A. Accurately locate and securely fasten sleeves to forms before concrete is poured; install in walls or partitions during the construction of the walls.
- B. Sleeve ends shall be flush with finished faces of walls and partitions.
- C. Pipe sleeves passing through floors shall project 25 mm (1 inch) minimum above the finished floor surface and the bottom of the sleeve shall be flush with the underside of the floor slab.

3.25 INSTALLATION - PIPE SUPPORT SYSTEMS

- A. Coordinate support locations with building structure prior to erection of piping. Also refer to approved shop drawings of equipment and approved piping layout and hanger layout drawings when locating hangers. Arrangement of supports shall facilitate operating, servicing and removal of valves, strainers, and piping specialties. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site.
- B. Upper attachments to Building Structure:
 - 1. New Reinforced Concrete Construction: Concrete inserts.
 - 2. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles (or other construction shown on the drawings) which are expansion-bolted to the concrete. Expansion bolting shall be located so that loads place bolts in shear.
 - 3. Steel Deck and Structural Framing: Upper attachments welded or clamped to structural steel members.
- C. Expansion Fasteners and Power Set Fasteners: In existing concrete floor, ceiling and wall construction, expansion fasteners may be used for hanger loads up to 1/3 the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to 1/4 of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.
- D. Special Supports:
 - 1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
 - 2. Where hangers cannot be adequately secured as specified, (for example, support for flow metering sensing lines, control piping)

special provisions shall be made for hanging and supporting pipe as directed by the COR.

3. Pipe supports, hangers, clamps or anchors shall not be attached to equipment unless specifically permitted by the specifications for that equipment or unless COR gives written permission. Attachments to boiler casings are prohibited.

E. Spring Hangers: Locate spring units within one foot of the pipe, breeching or stack attachment except in locations where spring assemblies interfere with pipe insulation. Adjust springs to loads calculated by hanger manufacturer.

3.26 CLEANING OF PIPING AFTER INSTALLATION

A. Flush all piping sufficiently to remove all dirt and debris. Fill piping completely. Velocity shall be equivalent to that experienced during normal plant operation at maximum loads. During flushing, all control valves, steam traps and pumps must be disconnected from the system. After cleaning is complete, remove, clean and replace all strainer baskets and elements. Reconnect all equipment. Provide safe points of discharge for debris blown from pipes. Flushing of the systems shall be witnessed by the COR or their representative. Provide documentation of system flow rates to flushing flow rates and for how long was the flow maintained.

3.27 TESTING

A. Testing of piping components is not required prior to installation. Valves and fittings shall be capable of withstanding hydrostatic shell test equal to twice the primary design service pressure except as modified by specifications on fittings, ASME B16.5. This test capability is a statement of quality of material. Tests of individual items of pipe, fittings or equipment will be required only on instruction of COR and at Government cost, except where required by the specifications for specific equipment such as the boilers.

B. After erection, all piping systems shall be capable of withstanding a hydrostatic test pressure of 1.5 times design pressure, as stipulated in ASME B31.1. Hydrostatic tests will be required only on boiler external steam piping, utilizing water as the test medium. Hydrostatic tests will be required on other piping when operating tests described are unsatisfactory, or when inspection of welds shows poor workmanship

and is subject to question by the COR. When hydrostatic tests show leaks, the COR will require necessary welding repairs, in accordance with ASME B31.1, at the Contractor's cost.

C. Perform operating test as follows:

1. All steam piping prior to insulation shall be subjected to steam at final operating pressure. Inspect all joints for leaks and workmanship. Corrections shall be made as specified. If insulation is installed prior to these tests the contractor shall be required to remove and reinstall insulation after the test has been completed at no additional cost or time to the Government.
2. Test main gas piping and LP gas piping at 2 times their respective design pressure up to a maximum of 103 kPa (15 psig), with compressed air for 2 hours with pressure source disconnected and with decay in pressure not to exceed 5 percent. Corrections to the readings are permissible to compensate for significant ambient temperature changes during the test period. Test joints with soap solution, check thoroughly for leaks.
3. Test boiler feedwater, condensate, vacuum and service water systems under service conditions and prove tight.
4. Test oil and compressed air systems under service conditions at pressure equal to highest setting of safety and relief valves in the individual systems.
5. Make corrections and retests to establish systems that have no leaks. Replace or recut any defective fittings or defective threads. Soldered material shall be thoroughly cleaned prior to resoldering. Back welding of threads is prohibited.

D. Hydrostatically test boiler external steam piping from boiler to header in approved manner with water at same time boiler is hydrostatically tested under the supervision of COR. Prior to hydrostatic test, remove all valves not rated for hydrostatic test pressure. Replace valves after tests are satisfactorily completed. Hydrostatic test pressure shall be 1.5 times design pressure and performed in accordance with ASME BPVC Section I.

E. Prepare and submit test and inspection reports to the COR within 5 working days of test completion and prior to covering the pipe.

- F. All tests shall be witnessed by the COR, their representative, or the commissioning agent and be documented by each section tested, date tested, and list of personnel present.
- G. Generally, insulation work should not be performed prior to testing of piping. Contractor may, at own option and hazard, insulate piping prior to test, but any damaged insulation shall be replaced with new quality as specified for original installation at Contractor's cost and time.
- H. Safety, Safety-Relief, Relief Valves: After installation, test under pressure in presence of COR. Test operation, including set pressure, flow, and blowdown in accordance with ASME BPVC. Install relief valve set at pressure no more than 1/3 higher than test pressure and replace safety valves of the appropriate pressure. Reset pressure setpoint of all relief valves to the appropriate pressures and replace safety valves after all tests have been completed. Contractor to provide written report of the reset with date and time stamp for each relief valve and replacement of the safety valves. Any deficiencies must be corrected, and retest performed. Refer to Section 23 52 39, FIRE-TUBE BOILERS for boiler safety valve test requirements.

3.28 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.29 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.30 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 8 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

**SECTION 23 50 11
BOILER PLANT MECHANICAL EQUIPMENT**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Feedwater deaerator maintenance, boiler feed pumps, condensate storage tank maintenance, compressed air systems, and other equipment that supports the operation of the boilers.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 09 91 00, PAINTING.
- F. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- G. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- H. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- I. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
- K. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- L. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- M. Section 26 29 11, MOTOR CONTROLLERS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
 - B16.9-2018Factory-Made Wrought Butt welding Fittings
 - B16.34-2017Valves Flanged, Threaded and Welding End
 - PTC 12.3 -1997Performance Test Code on Deaerators
 - ASME Boiler and Pressure Vessel Code -

BPVC Section VIII-2019 .Rules for Construction of Pressure Vessels,
Divisions 1 and 2

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

A53/A53M-2018Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless

A106/A106M-2019Standard Specification for Seamless Carbon
Steel Pipe for High Temperature Service

A234/A234M-2019Standard Specification for Piping Fittings of
Wrought Carbon Steel and Alloy Steel for
Moderate and High Temperature Service

A285/A285M-2017Standard Specification for Pressure Vessel
Plates, Carbon Steel, Low- and Intermediate-
Tensile Strength

A414/A414M-2019Standard Specification for Steel, Sheet,
Carbon, and High-Strength, Low-Alloy for
Pressure Vessels

A515/A515M-2017Standard Specification for Pressure Vessel
Plates, Carbon Steel, for Intermediate- and
Higher-Temperature Service

A516/A516M-2017Standard Specification for Pressure Vessel
Plates, Carbon Steel, for Moderate- and Lower-
Temperature Service

D. Environmental Protection Agency (EPA):

CFR 40,264.193-2014Containment and Detection of Releases

E. Department of Health and Human Services, Food and Drug Administration
(FDA):

CFR 21,175.300-2019Resinous and Polymeric Coatings

F. Society for Protective Coatings (SSPC):

SP 5-2014White Metal Blast Cleaning

G. Underwriters Laboratories (UL):

574-2019)Standard for Electric Oil Heaters

A. Department of Veterans Affairs (VA):

PG-18-10-2016Physical Security and Resiliency Design Manual
VHA Boiler Plant Safety Devices Testing Manual, Third Edition

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Feedwater Deaerator with Storage Tank and Accessories:
 - 1. Drawings showing replacement of deaerator spray head and BEI safety Devices.
 - 2. Replacement deaerator spry head and BEI safety devices submittal.
- E. Boiler Feedwater Pumps:
 - 1. Drawings with dimensions of assemblies of pumps and drivers.
 - 2. Catalog data and specification sheets on design and construction of pumps, drivers and couplings (flexible-coupled units).
 - 3. Motor efficiency and power factor at full load.
 - 4. Performance curves showing discharge head, required flow plus recirculation, net positive suction head required, efficiency, driver power, impeller diameter to be furnished. Refer to drawings for requirements.
 - 5. Pressure and temperature limitations of pump unit and accessories.
 - 6. Size and capacity of recirculation orifice.
 - 7. Data on variable frequency drive (VFD) units and pressure controllers.
- F. Compressed Air System:
 - 1. Drawing with dimensions and arrangement of air compressor, motor, air dryer, receiver and all accessories.
 - 2. Catalog data and specification sheets on the design and construction of air receiver, compressor, motor, air dryer, all accessories, condensate traps. Solenoid valves and filters.
 - 3. Performance data on compressors, after coolers, air dryer, relief valves.

- G. Test Data - Acceptance Tests, on-site: Four copies all specified tests.
- H. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- I. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or

any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Electric motor control cabinets/enclosures including VFDs in the boiler plant shall be minimum NEMA 4 or better.

2.2 FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES

1. Spray Valve Assemblies: Spring-loaded, guided stem, stainless steel and Monel, removable. Spring-loaded, guided stem types not required on spray-type units that operate with recycle pumps at constant flow rates through the spray valves in accordance with original manufacturer.

2. All other parts in deaerator section exposed to undeaerated liquids or gases must be constructed of stainless steel, cupro-nickel or equivalent.

3. Pipe Connections:

- a. Threaded for sizes 50 mm (2 inches) and under.
- b. Flanged, 1035 kPa (150 psig) ASME, for sizes above 50 mm (2 inches).
- c. Vortex breaker in boiler feedwater pump suction connection.
- d. Overflow Pipe:

- 1) Overflow pipe inside tank terminating 150 mm (6 inches) below low-level alarm set point. Operation of overflow control system must not allow water level to fall to the level of the overflow pipe inlet.
- 2) Overflow pipe sizing, based on required maximum feedwater flow output of feedwater deaerator:

Feedwater Flow Rate (kg/sec)	Feedwater Flow Rate (klb/hr)	Overflow Pipe Minimum Size (mm)	Overflow Pipe Minimum Size (in)
0 to 3.8	0 to 30	75	3
3.9 to 7.6	31 to 60	100	4
7.7 to 12.6	61 to 100	150	6

B. Steam Safety Valve: Mount on feedwater deaerator pressure vessel. Set pressure 103 kPa (15 psig). Capacity as shown. If not shown, minimum capacity 0.11 kg/sec (900 lb/hr). For safety valve construction requirements, refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.

2.3 CONDENSATE STORAGE TANK AND ACCESSORIES (NOT USED)

2.4 BOILER BLOWOFF TANK AND ACCESSORIES (NOT USED)

2.5 CENTRIFUGAL MULTI-STAGE BOILER FEEDWATER PUMPS

- A. Type: Two or more stages, centrifugal diffuser type, direct-coupled, vertical shaft, in-line, base-mounted, motor-driven, arranged as shown.
- B. Service: Design pumps and accessories for continuous service, 115 degrees C (240 degrees F) water, with flow rates ranging from maximum scheduled on the drawings (plus manufacturer's recommended recirculation) to 10 percent of maximum (plus manufacturer's recommended recirculation). Pumps shall be suitable for parallel operation without surging or hunting.

- C. Performance: Refer to schedules on drawings. Pump head-flow performance curve shall slope continuously upward to shut-off.
- D. Control - Boiler Feed: Flow rates will be controlled by automatic modulating feedwater valves on each boiler. Pumps shall be started and stopped manually. Pumps shall have variable frequency drives controlled by boiler feed header pressure electronic control system which must be provided. Control the header pressure at 160 psig, but confirm this value as part of start up. Test 10 points across full plant capacity. program transition from (1) pump to (2) pumps into VFD to ensure accurate transition.
- E. Construction:
1. Rotating elements shall be designed and balanced to conform to sound and vibration limits specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
 2. Mechanical seals shall have sealing face materials of carbon and tungsten or silicon carbide.
 3. Design bearings for two-year minimum life with continuous operation at maximum pump operating load. Bearings and shaft seals shall be water-cooled if recommended by pump manufacturer for the service.
 4. Materials of Construction:
 - a. Chambers: Stainless steel
 - b. Impellers: Stainless steel
 - c. Diffusers: Stainless steel
 - d. Shaft: Stainless steel
 - e. Suction-Discharge Chamber: Cast iron or stainless steel
- F. Recirculation Orifice: Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from overheating at shut-off and designed for low noise under the service conditions. Orifices must not exceed sound level limits in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- G. Spare Parts: Provide complete rotating assembly for each pump size and type suitable for field installation by plant personnel. Assembly shall include impellers, diffusers, chambers, shaft, seals, and bearings.
- H. Shaft Couplings: Pump manufacturer's standard. Provide coupling guard.
- I. Electric Motors: High efficiency type, open drip proof. Select motor size so that the motor is not overloaded at any point on the pump head-

flow performance curve. Design motor for 40 degrees C (104 degrees F) ambient temperature. For efficiency and power factor requirements refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

J. Interface with Computer Workstation: Provide devices to signal computer work station that motor is on or off.

2.6 CONDENSATE TRANSFER PUMPS, FLEXIBLE-COUPLED, END SUCTION, CENTRIFUGAL (NOT USED)

2.7 CONDENSATE TRANSFER PUMPS, CLOSE-COUPLED, END SUCTION, CENTRIFUGAL (NOT USED)

2.8 CONDENSATE RETURN PUMP UNITS (ELECTRIC, PAD-MOUNTED)

- A. Type: Factory-assembled units consisting of vented horizontal pad-mounted receiver tank, simplex or duplex motor-driven pumps as shown, interconnecting piping, motor controls, and accessories. Arrangement of pumps, tank and accessories shall be as shown or specified.
- B. Service: Unit shall be designed to receive, store, and pump steam condensate having temperature as shown (212F). Pumps and motors shall be suitable for continuous service.
- C. Performance: Refer to schedules on the drawings.
- D. Pumps: Centrifugal or turbine-type as shown.
 - 1. Centrifugal Pumps: Bronze-fitted, vertical shafts, with mechanical shaft seals. Stainless steel or alloy steel shafts with bronze shaft sleeves. Pump shall be designed to allow removal of rotating elements without disturbing connecting piping or pump casing mounting. Bearings shall be grease-lubricated ball or roller type. Provide casing wearing rings.
- E. Electric Motors: Open drip proof. Select motor sizes so that the motors are not overloaded at any point on the pump head-flow performance curve. Motor shall be designed for 40 degrees C (104 degrees F) ambient temperature.
- F. Receiver Tank: Reuse existing.
- G. Controls: Existing controls shall operate the new pumps. The pump shall be able to operate based on these control inputs.
 - 1. Pump Operation: Provide float switches mounted on receiver tank to start and stop water pumps in response to changes in the water level in the receiver. Float switches shall be adjustable to permit the

controlled water levels to be changed. Floats and connecting rods shall be copper, stainless steel or bronze. When a duplex pump unit is used, provide an alternator and a control to automatically start the second pump, when the first pump fails in keeping the receiver water level from rising.

2. Starters: Provide combination magnetic starters with fusible disconnect switches or circuit breakers. Provide low voltage control circuits (120-volt maximum).
3. Indicating Lights: Provide red light for each pump to show that the pump is running, green lights to show power is on.
4. Manual Selector Switches: Provide "on-off-automatic" switch for each pump.
5. Electrical Wiring: Shall be enclosed in liquid-tight flexible metal conduit. Wiring shall be suitable for 93 degrees C (199 degrees F) service.
6. Control Cabinet: NEMA 250, Type 4 or better, enclosing all controls, with manual switches and indicating lights mounted on the outside of the panel. Attach to pump set with rigid steel framework unless other mounting is shown on the drawings.

H. Sound and Vibration: Pump units shall conform to sound and vibration limits specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.

2.9 CONDENSATE RETURN PUMP UNITS (ELECTRIC, SUMP-TYPE) (NOT USED)

2.10 MECHANICAL CONDENSATE PUMP (PRESSURE-POWERED CONDENSATE PUMP) (NOT USED)

2.11 VACUUM HEATING PUMP UNITS (NOT USED)

2.12 FLASH TANK (NOT USED)

2.13 FUEL OIL PUMPING EQUIPMENT (BURNER FUEL) (NOT USED)

2.14 FUEL OIL HEATERS AND ACCESSORIES (NOT USED)

2.15 NO. 2 FUEL OIL TEMPERATURE CONTROL SYSTEM (NOT USED)

2.16 COMPRESSED AIR SYSTEM

- A. Provide complete compressed air system to provide shop (cleaning and maintenance) air, and to serve controls and instruments. Compressed air systems shall include compressors, motor drives, receivers, aftercoolers, filters, air dryers and accessories as scheduled, as shown on the drawings and as specified.

B. Compressors:

1. Type: Rotary screw, two-stage, air-cooled, intercooled, V-belt drive.
2. Performance: Shall be as shown on the drawings. Shall be suitable for continuous service.
3. Construction:
 - a. Lubrication: Splash type with low oil level automatic shutdown switch, or pressure type with low oil pressure automatic shutdown switch.
 - b. Unloading: Provide automatic cylinder air pressure unloader to prevent compressor starting under load.
 - c. Inlet Filter: Dry-type with replaceable cartridge.
 - d. Cylinders: Shall be removable from crankcase.

C. Receivers: Vertical or horizontal cylindrical tanks as shown on the drawings. Construct in accordance with the ASME BPVC Section VIII with inspection under the rules of the National Board of Boiler and Pressure Vessel Inspectors. Design pressure 1035 kPa (150 psig) minimum.

D. Compressor and Receiver Accessories:

1. Automatic Condensate Traps: Provide on lowest point of receiver. Size shall be suitable for compressor air delivery.
2. Safety Valve: Provide on receiver, set pressure lower than receiver design pressure. Capacity of valve at set pressure shall be greater than maximum output of all compressors supplying receiver.
3. Pressure Gauges: Provide on receiver and as shown. Refer to specification Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
4. Receiver Piping Connections: Shall include air in, air out, safety valve, automatic drain, valved manual drain and valved pressure gauge.

E. Compressor Controls:

1. Compressors Serving Boiler Plant Controls or Instruments: Dual control enabling the manual selection of either automatic start-stop control (actuated by adjustable receiver pressure switch), or constant speed control in which the compressor runs constantly but only compresses air between predetermined adjustable receiver pressure limits.

2. Controls shall operate on 120 volts maximum. Provide "on-off-automatic" control for each compressor.
- F. Electrical Motors and V-Belt Drives: Motors shall be TEFC designed for 40 degrees C (104 degrees F) ambient temperature. Select V-belt drives in accordance with manufacturer's recommendations for frequent start-stop service. Provide belt guard that encloses belts on all sides.
- G. Vibration Isolation: Refer to specification Section 23 21 11, BOILER PLANT PIPING SYSTEMS, for isolators required in piping.
- H. Refrigerated Air Dryer: Shall be refrigerant-type with capacity sufficient for all pneumatic controls and instruments in the boiler plant. Cycling type which turns on and off in response to load. Base capacity ratings on 690 kPa (100 psig) inlet pressure; 38 degrees C (100 degrees F) air inlet temperature; 38 degrees C (100 degrees F) ambient air temperature. Unit shall maintain dewpoint at 2 to 4 degrees C (35 to 40 degrees F) at 690 kPa (100 psig) air pressure. Provide unit with "power on" light, automatic water drain trap. Provide reheat of output air by heat exchange with input air to decrease condensation on air pipes. Design unit for 1035 kPa (150 psig).
- I. Air Filter: Located in compressed air line between receiver and air dryer, coalescing type, designed to remove oil, entrained water mist, and dirt from the compressed air. Provide automatic drain valve piped to nearest drain. Size unit for maximum pressure drop of 3.5 kPa (0.5 psig) at normal air flow rate. Design unit for 1035 kPa (150 psig) air pressure.
- J. Spare Parts:
1. Complete set of drive belts.
 2. Two filter cartridges for each compressor intake filter.
 3. Two filter cartridges for air dryer intake filter.

2.17 STEAM VENT SILENCER (MUFFLER) (NOT USED)

2.18 BOILER WATER AND DEAERATOR WATER SAMPLE COOLERS (NOT USED)

2.19 CHEMICAL FEED SYSTEMS (NOT USED)

2.20 AUTOMATIC CONTINUOUS BOILER BLOWDOWN CONTROL SYSTEM (NOT USED)

2.21 CONTINUOUS BLOWDOWN HEAT RECOVERY SYSTEM (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Feedwater Deaerator with Storage Tank and Accessories.
 - 1. Clean interior of equipment before placing in service.
 - 2. All controls, safeties, set points, etc. must conform to the VHA Boiler Plant Safety Devices Testing Manual.
- C. Boiler Feed Pumps:
 - 1. For base-mounted horizontal-shaft pumps, connect base drain to 20 mm (3/4 inch) pipe. Extend pipe to nearest open sight or floor drain.
 - 2. Align pumps and drivers at the factory. At job site, a millwright shall level, shim, bolt, and grout the base plates or base frames onto the concrete pads, and shall also check the alignments of flexible-coupled pumps and drivers and make corrections necessary. Check alignment when both pump and driver are at normal operating temperature.
 - 3. Where packaged deaerator-feed pump unit is required, boiler feed pump base plates shall be welded or bolted to deaerator support frame.
 - 4. If water-cooled bearings or quenched or flushed or water-cooled stuffing boxes are provided on pumps, contractor shall install on each pump valved 15 mm (1/2 inch) piping connections to cold water supply, and 15 mm (1/2 inch) drains to nearest open sight drain. Provide unions at all connections to pumps.
- D. Compressed Air System: Pipe all drain connections individually to nearest floor drain. Use 15 mm (1/2 inch) piping. Provide union at each drain connection on the equipment.

3.2 TESTING AND BALANCING FEEDWATER DEAERATOR WITH STORAGE TANK AND ACCESSORIES

- A. Demonstrate the ability of the deaerator to perform as specified in regard to oxygen removal and outlet temperature, over the required output flow range and input temperature range of unit. Test performance at 5 percent and 100 percent of capacity, and at two intermediate points to be selected by the COR. Repeat test two times at each load point.
- B. Determine temperatures and pressures by calibrated thermometers and pressure gauges.
- C. Utilize the specified colorimetric comparator type dissolved oxygen test kit. After completion of tests, clean the test kit apparatus, replace all ampoules used and parts missing or broken, and deliver the kit to the COR.
- D. Various impurities in feed water can interfere with the colorimetric test. When impurities are present, the Contractor shall be prepared to test for dissolved oxygen using the titration test as described in ASME PTC 12.3. COR may permit other test methods.
- E. This test shall be performed in conjunction with any boiler tests that are specified.
- F. Prior to requesting final tests, pretest unit using method specified for final test. All final tests must include at the minimum the tests listed in the VHA Boiler Plant Safety Devices Testing Manual. Submit test data for review.
- G. All permanent work platforms shall be in place before testing. The use of or need for step ladders to perform any inspection, test, or maintenance shall be considered a failure to install the equipment in accordance with specifications that require access to equipment. The contractor shall correct at no additional cost or time to the Government before beneficial use can start.

3.3 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.4 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- C. Comply with Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.

- - - E N D - - -

**SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies flue gas exhaust system and all accessories from the boiler outlet to the stack outlet to the atmosphere. Flue gas recirculation (FGR) ductwork (if required by burners furnished) is also specified.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 05 50 00, METAL FABRICATIONS: Frames and supports.
- F. Section 07 60 00, FLASHING AND SHEET METAL: Roof Penetrations.
- G. Section 09 91 00, PAINTING.
- H. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- I. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- J. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- K. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- L. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT: Boiler Draft Control System.
- M. Section 23 52 39, FIRE-TUBE BOILERS: Economizers.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Institute of Steel Construction (AISC):
325-2017Steel Construction Manual, 14th Edition

C. ASTM International (ASTM):

- A36/A36M-2019Standard Specification for Carbon Structural Steel
- A242/A242M-2018Standard Specification for High-Strength Low-Alloy Structural Steel
- A307-2016Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
- A563-2019Standard Specification for Carbon and Alloy Steel Nuts
- A568/A568M-2019Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled

D. American Welding Society (AWS):

- D1.1/D1.1M-2020Structural Welding Code-Steel

E. Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):

- SP-58-201Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

F. National Fire Protection Association (NFPA):

- 31-2016Standard for the Installation of Oil-Burning Equipment
- 54-2018National Fuel Gas Code
- 211-2019Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

G. Underwriters Laboratories (UL):

- 103-2010 (R2012)Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances
- 441-2010 (R2016)Standard for Gas Vents
- 641-2010 (R2013)Standard for Type L Low-Temperature Venting Systems
- 1738-2010 (R2017)Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Design, materials, weights, construction, pressure and temperature limitations of breeching and stack systems, and flue gas recirculation system. Structural design data.
- E. Drawings showing all components, system arrangement and dimensions.
- F. Design, construction, material specifications, allowable movements, movement forces, pressure and temperature limitations of expansion joints.
- G. Damper design, construction, pressure and temperature limitations, pressure loss at design flow, and leakage of closed damper.
- H. Support designs, locations and loads for entire assembly.
- I. Written statement from boiler/burner manufacturer that the design of the system is satisfactory to achieve the required boiler/burner performance.
- J. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- K. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- L. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Provide scale drawings showing nominal dimensions and weight of the systems.
- B. Boiler and burner manufacturer shall review complete system from boiler flue gas outlet to stack outlet to atmosphere and advise the Government of any changes required to meet boiler and burner performance requirements. Note the altitude of plant site.
- C. If a double wall, factory-fabricated, positive pressure breeching and stack system is provided, the manufacturer shall completely engineer the entire system and provide all components. Manufacturer's representative shall provide installation instructions prior to start of construction, train the installers and certify in writing to the COR that the entire installation complies with the official standards of the manufacturer and with the project contract documents.
- D. Flue gas recirculation ductwork shall be designed and provided by the burner manufacturer.
- E. Conform to NFPA 54 and NFPA 31 for sizing, design of flue gas vents, and installation of fuel burning equipment and appliances.
- F. Components coming in contact with the products of combustion shall carry the appropriate UL or ULC listing.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

PART 2 - PRODUCTS

2.1 BREECHING, STACKS, FGR DUCTWORK

- A. Refer to drawings for arrangement and dimensions, except FGR ductwork shall be designed by the burner manufacturer. FGR ductwork construction, material and gauge thickness shall be the same as in the

main chimney/stack. Connections to boilers and economizers must comply with the written recommendations of the boiler and economizer manufacturers. Ninety-degree tee sections are prohibited. Intersections must be made with lateral tees.

- B. Service: Design for continuous 315 degrees C (600 degrees F), 12 kPa (50 inches WC) positive and negative internal pressure, for a wind-loading for outside stacks 41 PSF.
- C. Pre-engineered, Pre-Fabricated, Double-Wall System:
1. Complete factory-built system, all components and installation engineered and provided by manufacturer of system.
 2. Provide double wall metal stacks, tested to UL 103 and UL 641, and UL-listed, for use with building heating equipment, in compliance with NFPA 211.
 3. Corrosion-resistant steel, double-wall, circular cross section, positive pressure, blanket insulation between walls.
 4. Factory-built standard sections connected in the field with joining system designed and provided by system manufacturer. Designed to be pressure and vacuum-tight, no deformation, at the service conditions specified.
 5. System manufacturer's engineered support system, attached to structural members of the building, with expansion joints between rigid supports. Thermal expansion shall be handled by expansion joints and variable spring hangers. Thermal expansion and weight of system shall not impose loads in excess of that allowed by manufacturer of boiler, economizer, or any other equipment, or exceed capabilities of building structure. Spring hangers shall conform to MSS SP-58, Type 51, and variable spring.
 6. Design for UL-listed clearance to combustible materials and clearance to non-combustible materials.
 7. Inner Wall: Stainless steel, Type 304, 0.89 mm (0.035 inch) minimum thickness for diameters 900 mm (36 inches) and smaller and 1.2 mm (0.047 inches) minimum thickness for diameters greater than 900 mm (36 inches) and 1200 mm (48 inches) and less.
 8. Outer Wall: Aluminized or galvanized steel except 304 stainless steel outside of building, 0.6 mm (0.024 inch) minimum thickness for inner wall diameter 800 mm (31-1/2 inches) and less, 0.89 mm (0.035

- inch) minimum thickness for inner wall diameter over 800 mm (31-1/2 inches) and 1200 mm (48 inches) and less.
9. Insulation Between Walls: Fiberglass or mineral wool, 315 degrees C (600 degrees F). Minimum thickness 50 mm (2 inches).
 10. Bands for Joining Sections: Same material as section being joined. Utilize sealant provided by system manufacturer.
 11. Roof and wall penetrations shall be manufacturer's standard ventilated thimble. Conform to Section 07 60 00, FLASHING AND SHEET METAL.
 12. Stack Outlet: Provide as shown, double cone rain cap or other type termination designed by manufacturer of the stack system.
 13. Drain Section: Provide inside building below roof to drain rain water from stack. Extend drain pipe to floor drain.
 14. Guys: Provide stack guy wires above roof, with spring-loaded tensioners, in accordance with printed instructions of stack manufacturer.

2.2 BOILER OUTLET DAMPERS AND ACCESSORIES (NOT USED)

2.3 EXPANSION JOINTS

- A. Provide sufficient types, quantities, and locations of expansion joints to completely absorb all thermal expansion of the system without imposing excessive loads on equipment or building structure. Fabric joints shall be used on single-wall stack and breeching system. On factory-fabricated double wall stack or breeching system, use slip-type, bellows-type, or fabric expansion joints engineered by designer of the stack and breeching system.
- B. Service: Design for 300 degrees C (572 degrees F), 5 kPa (20 inches WC) positive and negative internal pressure, continuous duty.
- C. Construction, Fabric Joints:
 1. Fabric: High strength, designed for dewpoint service.
 2. Internal Baffles: Carbon steel with stiffeners. Designed to protect interior surfaces of fabric from wiping action of the flue gases.
 3. Welded frame, 6 mm (1/4 inch) thick ASTM A568/A568M steel with 100 mm (4 inch) minimum flange height, flat-belt design, fabricated by expansion joint manufacturer. Fabric element bolting, 10 mm (3/8 inch) diameter, 150 mm (6 inch) maximum centers.

- D. Construction, Factory-Fabricated Double-Wall System Joints:
1. Materials: Same as factory-fabricated breeching system.
 2. Packing Gland: High temperature rating. Provide seal between sliding and fixed portions of joint.

2.4 ACCESSORIES

- A. Drains: Provide threaded pipe connection to allow drainage at all low points and drain connections in stack and breeching systems. Slope piping system to the drain. Pipe size shall be 25 mm (1 inch) minimum.
- B. Instrument Ports: Locate on individual stack or breeching serving each boiler. Locate in non-turbulent zone within 3600 mm (12 feet) of boiler room floor between boiler and economizer (when economizer is provided) or locate accessible from platform. Provide separate ports for the following:
1. Flue gas oxygen analyzer: Coordinate with analyzer furnished.
 2. Stack temperature sensor: Coordinate with sensor furnished.
 3. Draft gauge: 25 mm (1 inch) diameter coupling, plugged.
 4. Test instruments: 25 mm (1 inch) diameter coupling, plugged.
- C. Access Doors: Bolted, gasketed, insulated, with handles. Provide where shown. Minimum opening 400 mm x 400 mm (16 inches x 16 inches).

2.5 TYPE B DOUBLE WALL GAS VENTS

- A. Fabrication: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

2.6 DOUBLE WALL VENTING FOR CONDENSING APPLIANCES (NOT USED)

2.7 SINGLE WALL VENTING FOR CONDENSING APPLIANCES (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 INSTALLATION - PRE-ENGINEERED, PRE-FABRICATED DOUBLE WALL SYSTEM

- A. Supports: Completely support all systems from the building structure without overloading the building structure or the connected equipment. Support system shall be engineered by the system manufacturer and shall accommodate thermal expansion.

- B. Factory-Fabricated Stack or Breeching System:
 - 1. Install in accordance with manufacturer's printed instructions, NFPA 54 and NFPA 31.
 - 2. Deliver a copy of the instructions to the COR prior to commencing the installation.
 - 3. Representative of manufacturer shall provide field training on all installation techniques to all installers.
- C. Connect 25 mm (1 inch) minimum pipes with ball valves to breeching and stack drains. Extend to floor drain.
- D. Boiler or Economizer Outlet Dampers: Locate so that there is no restriction in the flow of flue gas recirculation (if provided).
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.

3.3 INSTALLATION - CUSTOM-DESIGNED, FIELD-FABRICATED, STEEL SINGLE WALL SYSTEM (NOT USED)

3.4 INSTALLATION OF VENT FOR CONDENSING APPLIANCES (NOT USED)

3.5 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.7 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

**SECTION 23 52 39
FIRE TUBE BOILERS**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies packaged fire tube boiler with trim (accessories), dual fuel (natural gas and Propane-air mixture) burner, fuel valve and piping trains, flue gas economizer, and other accessories.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- F. Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT.
- I. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- J. Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- K. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT.
- L. Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
- M. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. ASTM International (ASTM):
 - A106/A106M-2019Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

- A178/178M-2019Standard Specification for Electric-Resistance-Welded Carbon Steel and Carbon-Manganese Steel Boiler and Superheater Tubes
- A254-2019Standard Specification for Copper-Brazed Steel Tubing
- C612-2019Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- D396-2019Standard Specification for Fuel Oils
- C. American Society of Mechanical Engineers (ASME):
 - B31.1-2018Power Piping
 - ASME Boiler and Pressure Vessel Code:
 - BPVC Section I-2019Rules for Construction of Power Boilers
 - BPVC Section II-2019Materials
 - BPVC Section VII-2019 Recommended Guidelines for the Care of Power Boilers
 - BPVC Section VIII-2019 Rules for Construction of Pressure Vessels
 - BPVC Section IX-2015 Welding, Brazing, and Fusing Qualifications Performance Test Code (PTC):
 - PTC 4-2013Fired Steam Generators
- D. Environmental Protection Agency (EPA):
 - CFR 40, PART 60, Appendix A, Method 9-2017Visual Determination of the Opacity of Emissions from Stationary Sources
- E. Department of Health and Human Services, Food and Drug Administration (FDA):
 - CFR 21, 173.310-2016.....Boiler Water Additives
- F. National Fire Protection Association (NFPA):
 - 85-2019Boiler and Combustion Systems Hazards Code
- G. Department of Veterans Affairs (VA):
 -VHA Boiler Plant Safety Devices Testing Manual, Third Edition

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 52 39, FIRE TUBE BOILERS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Boiler:
1. Complete catalog information and outline drawings of boiler, burner, and accessories with dimensions including tube removal space and access door opening space.
 2. Catalog cuts showing arrangement and construction of pressure parts, casing, internals, and support frame.
 3. Piping connection sizes, locations, types (threaded or flanged).
 4. Technical data including temperature rating and arrangement of refractory and insulation.
 5. Steam nozzle construction, including the maximum forces and moments that are allowed to be imposed by connected piping.
 6. Amount of heating surface and combustion volume.
 7. Weight of boiler empty and flooded including burner and boiler and burner accessories, including corner weights and center of gravity dimensions for coordination with foundation design.
 8. Design pressures and temperatures.
 9. Recommended anchorage of boiler support frame to foundation.
 10. Furnace viewport construction, locations.
 11. Dimensioned location of normal water line, lowest and highest permissible water level, set points of water level alarms and cutoffs.
 12. Predicted external surface temperature of front, rear and sides of boiler.
- E. Boiler Trim: Includes bottom blowoff valves, water level alarm and cutoff devices, water level gauge, low water cutoffs, piping, all valves and fittings furnished by boiler manufacturer, feedwater control system, steam safety valves, steam pressure gauge, stack thermometer, draft gauge, and steam pressure switches.
1. Design, construction, arrangement on the boiler.

2. Pressure and temperature limitations.
 3. ASTM numbers and schedule numbers of piping.
 4. Type and pressure ratings of pipe fittings.
 5. Flow and pressure drop data on feedwater regulating valves.
 6. Technical data on water level control system.
 7. Scale ranges of gauges, thermometers and pressure switches.
 8. Location of water level sensing and indicating device set points in relation to normal water line and lowest and highest permissible water levels of boiler.
 9. Set pressure and capacity of safety valves.
- F. Burner and Fuel Valve and Piping Trains:
1. Catalog data and drawings showing burner assembly and fuel train arrangement.
 2. Outline drawings of flue gas recirculation (FGR) ductwork (if applicable).
 3. Outline drawings of sound attenuators on forced draft fan intake or discharge.
 4. Drawings showing assembly of throat refractory into furnace.
 5. Type and temperature rating of throat refractory.
 6. Drawings and catalog data on all equipment in igniter (pilot) train, and main fuel trains. Include data on pressure and temperature ratings, flow versus pressure drop, performance characteristics. Include complete data sound attenuators and motors.
 7. ASTM numbers and schedule numbers on all piping.
 8. Type and pressure ratings of pipe fittings.
 9. Burner flow and pressure data:
 - a. Main burner fuel pressures and flows at maximum required firing rate.
 - b. Igniter (pilot) fuel flow and burner pressure.
 - c. Natural gas main fuel pressure at inlet and outlet of main burner pressure regulator.
 - d. Igniter (pilot) fuel pressures (natural gas and LP gas) at inlet and outlet of burner-mounted pressure regulators.
 - e. Forced draft fan static pressure, power and air flow at maximum firing rate.
 10. Full load efficiency and power factor of all motors.

11. Predicted sound level at maximum firing rate on each main fuel.
 12. Weight of burner assembly.
 13. Steps required to change from one fuel source to another.
- G. Burner Management (Flame Safeguard Control) System: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- H. Flue Gas Economizer:
1. Drawings showing arrangement and dimensions of unit and all accessories.
 2. Design and construction of unit and accessories including safety relief valve.
 3. Weight of entire unit, empty and flooded.
 4. Pressure and temperature limitations of unit and accessories.
 5. Performance data on safety relief valve.
 6. Manufacturer's support requirements.
- I. Boiler, Burner, Economizer Predicted Performance Data:
1. At Maximum Required Output: On each fuel at site altitude, with and without economizer (if applicable) in service, at 15 percent excess air. Data must include fuel and steam flow, boiler flue gas outlet temperature, economizer (if provided) flue gas outlet temperature, steam quality, boiler efficiency, furnace pressures, and predicted boiler radiation and unaccounted losses, feedwater and flue gas pressure losses in the economizer (if provided).
 2. At low fire, 25 percent, 50 percent, and 75 percent of Maximum Required Output. Excess air, CO ppm, NO_x ppm on each fuel.
- J. Schematic wiring diagram of boiler control system showing all components, all interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring and separation of the burner control system from the Burner Management (Flame Safeguard Control) system.
- K. ASME "P" Forms, Manufacturer's Data Report, on boiler and economizer construction - submit after boiler and economizer are fabricated.
- L. Pretest Data - Boiler, Burner, Controls: As required by Part 3.
- M. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.

2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
 4. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician, and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- N. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

- A. Coordinate all new and existing equipment and conditions. This includes, but is not limited to: boiler, boiler trim, burner, fuel valve and piping trains, gas pressure regulators and available gas pressure, compressed air system for control systems, economizer (if provided), breeching and stacks.
- B. The model and size of the proposed burner shall have been applied to at least three fire tube boilers which are similar in size, proportion, number of passes and furnace dimensions to the proposed boiler. In each of the three installations, burner performance shall have conformed to requirements specified in the paragraph, BURNER AND FUEL TRAINS, subparagraph, PERFORMANCE of this Section. Provide list of these installations, and name, address, and telephone number of person familiar with each project who will serve as a reference source.
- C. Regardless of fuel input rating, the equipment, installation and operation shall conform to NFPA 85. Where conflicts exist between NFPA 85 and this specification, this specification will govern.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable 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 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.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
 - 1. Red-lined, hand-marked drawings are to be provided, with one paper copy and a scanned PDF version of the hand-marked drawings provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.7 PROJECT CONDITIONS

- A. Fuels to be Fired, Main Burner: Natural gas and Propane air mixture.
- B. Igniter (Pilot) Fuels: Natural Gas and LP gas (propane).
- C. Natural Gas: High heating value is reported as 1100 Btu/cubic foot at gas company base pressure and temperature. Pressure provided to the inlet of the boiler-mounted regulators will be 10 psig gauge as maintained by main regulator station.
- D. LP Gas: Propane furnished directly to the Government for igniter (pilot) fuel by a local supplier. Regulators at tank area will be set at 34 kPa (5 psig) gauge. Serves as igniter fuel when there is an interruption to the natural gas supply.

PART 2 - PRODUCTS**2.1 BOILER**

- A. Type: Factory-assembled packaged Scotch marine horizontal fire tube high pressure industrial steam boiler. Three or four pass wetback design with internal furnace located below center of boiler shell. Designed for natural gas and Propane Air Mixture.
- B. Service: Continuous long-term generation of steam throughout the burner firing range in conformance to the specified performance requirements with feedwater supply at 100 degrees C (212 degrees F).
- C. Performance:
 - 1. Steam Output Quantity and Pressure: Refer to schedules on drawings.
 - 2. Steam Output Quality: 99 percent minimum at all steam flow rates. Based on water quality in boiler of 2200 ppm maximum total solids, 15 ppm maximum suspended solids, 440 ppm maximum alkalinity.
 - 3. Minimum Efficiency at Required Maximum Output:
 - a. Natural Gas Fuel (37.3 MJ/cubic meter) (1000 Btu/cubic foot): 82 percent at 15 percent excess air.
 - b. Propane Air Mixture fuel: 1000 Btu/cubic foot
- D. Heating Surface: Heating surface is defined as the fireside area of the furnace and combustion chamber plus inside (gas side) circumferential area of all convection tubes. Minimum surface shall be 470 square centimeters per kW (5 square feet per boiler horsepower).
- E. Design Pressure: Shall equal the ASME-stamped maximum allowable working pressure of 1380 kPa (200 psig). Purpose of high design pressure is to

provide additional corrosion allowance and additional safety margin to perform safety device testing.

F. Construction:

1. Codes: Comply with ASME BPVC Section I, ASME BPVC Section II, ASME BPVC Section VII, and ASME BPVC Section IX.
2. Tubes: ASTM A178/178M, Grade A, smooth wall inside and outside. Minimum thickness 2.7 mm (0.106 inches). Flue gas spinners or turbulators are prohibited.
3. Manway: Cover and yokes shall be forged steel. Manway shall seal tight with no leakage. Provide non-asbestos gaskets.
4. Handholes: Covers and yokes shall be forged steel or cast iron. Handholes shall seal tight with no leakage. Provide non-asbestos gaskets.
5. Access to Tubes and Furnace: Provide hinged and davited doors and access panels to permit access to all tubes, burner head, and furnace for cleaning, repairs and replacement. Doors wider than the radius of the boiler shell shall be davited and shall be operable by one person. Hinges or davits are not required for access panels less than 600 mm (2 feet) in width and height. All doors and panels shall have non-asbestos gaskets and shall be sealed tight with capscrews threaded into brass nuts. Panels shall have handles.
6. Shell Piping Connections: Flanged, except threaded is permitted for pipe sizes less than 65 mm (2-1/2 inches). Connections shall include, but not be limited to:
 - a. Steam nozzle shall be 2070 kPa (300 psig) ASME flanged. Design nozzle and shell assembly to withstand forces and moments imposed by connected piping. Studding nozzle is prohibited.
 - b. Locate manual steam vent on top of boiler shell to permit access to vent gate valve from platform located above boiler.
 - c. Locate safety valve outlets to permit straight run of vents through roof and to permit valve handle access from platform located above boiler.
 - d. Connections for water level control, alarm and indication devices.

- e. Connections for boiler feed water, chemical admission, combined continuous blowdown and water sampling. Locate below normal water level and as shown.
 - f. Bottom blowoffs. Locate to permit complete collection of sediment and complete drainage.
 - g. Pressure gauge and pressure switch connections. (May be connected to water level controller steam piping.)
7. Support System: Provide proper support of all elements of the boiler, burner, and accessories during shipment, rigging, and in final installation. Arrange supports to permit thermal expansion. No element of the boiler or accessories shall be overstressed, displaced, have cracks, broken welds, or excessive deflection. All vertical elements of the boiler and accessories shall be plumb, and all horizontal elements shall be level.
- a. Base Frame: Design for mounting on flat concrete base. All elements shall be level. Provide attachments for anchorage to the concrete foundation.
 - b. Rigging and Jacking: Provide lifting lugs and provisions for jacking. Painted stencils shall identify jacking locations.
 - c. Platform Support Brackets: Provide brackets attached to boiler shell to support field-installed valve and manway access catwalk alongside top of boiler.
8. Refractory and Insulation: Boiler manufacturer's standard and experience proven design except insulation on the boiler shell shall be a minimum of 50 mm (2 inches) thick. No part of the external casing shall exceed 16 degrees C (60 degrees F) above ambient, except for areas within 300 mm (1 foot) of the casing penetrations.
9. Casing: Sheet steel covering all areas of boiler shell. Flash or seal all openings at top of boiler at piping and flue connections to prevent leakage of water into insulation. Provide a 300 mm (1 foot) minimum width section of heavy gauge reinforced casing or heavy density insulation minimum 96 kg per cubic meter (6 pounds per cubic foot) along the top centerline of the entire length of the boiler to permit walking on top of the boiler without denting the casing.
10. Observation Port: Provide single port at rear of furnace located to permit flame observation. Furnish with one clear and one tinted

interchangeable heat resisting glass, gas-tight operable metal closure between furnace and glass, forced air cooling to reduce moisture condensation on glass.

- G. Factory Inspection and Certification: Inspect the completed boiler assembly in accordance with the requirements of the ASME BPVC Section I. The boiler inspection shall be certified. Submit four copies of ASME Form P-2 for each boiler.
- H. Finish: Provide surface preparation, heat-resistant prime and two finish coats using standard color of the boiler manufacturer.
- I. Controls and Safety Devices: In accordance with NFPA 85.

2.2 BOILER TRIM (ACCESSORIES)

- A. Conform to ASME BPVC Section I.
- B. Steam Safety Valves:
 - 1. Capacities certified by National Board of Boiler and Pressure Vessel Inspectors (NBBI).
 - 2. Type: Cast-Steel bodies, side outlet, flanged or threaded inlet and outlet, lifting lever, dual control rings, stainless steel trim.
 - 3. Settings and Adjustments: Factory set, sealed, and stamped on nameplate. Set pressures as shown. Set pressure of lowest pressure valve shall not exceed normal boiler plant operating pressure by more than 207 kPa (30 psig). Provide 34 kPa (5 psig) difference in setting between each of the valves.
 - 4. Valve must be testable.
- C. Steam Pressure Gauge:
 - 1. Case: Turret-style, bottom connection, threaded ring, blowout disc in rear.
 - 2. Dial: 200 mm (8 inch) minimum diameter, non-corrosive, black markings on white background.
 - 3. Measuring Element: Bourdon tube designed for steam service.
 - 4. Movement: Stainless steel, rotary.
 - 5. Pointer: Micrometer adjustable, black color.
 - 6. Window: Laminated safety glass, or plastic.
 - 7. Accuracy: One half percent of the full span.
 - 8. Range: 0 - 300 psig gauge.

9. Installation: Stop valve, steel piping, valved blowdown, siphon, union at gauge, and valved connection for inspector's gauge. Refer to Detail, FIRE TUBE BOILER.

D. Water Level Safety and Operating Controls and Indicators:

1. Provide high and low water warning alarms, primary and auxiliary low water burner cutoffs, automatic electronic modulating feedwater level control system, gauge glass.
 - a. High and low water warning alarms shall operate bell and separate high and low water level indicating lights on boiler control panel and shall not shut down the burner.
 - b. Primary and auxiliary low water burner cutoff devices shall be in two separate water columns, piped individually to the boiler water spaces. One device shall be float-type, the other device shall be conductivity probes. Primary and auxiliary cutoffs shall require separate manual reset. Non-latching shunt switches shall allow blowdown of water columns without shutting down the burner.
 - c. Water level set points for all devices shall be as recommended by boiler manufacturer.
 - d. Water level control system shall maintain the water level within limits established by boiler manufacturer for normal water level with no tripping of high and low-level alarms with instantaneous load swings of 25 percent of boiler capacity. Feedwater pump will operate continuously.
 - e. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT for detailed operation of all indication, monitoring, alarm and control devices.
2. Water Column Unit with Water Level Controller, Gauge Glass, Water Level Sensor for Primary Low Water Cutoff:
 - a. Float-type electric or electronic modulating water level control device and primary low water cutoff. As an option to the float type device, electronic self-checking magnetostrictive or capacitance devices may be provided.
 - b. Height of water column and gauge glass shall be sufficient to show water level in the gauge glass at least 15 mm (1/2 inches) above high water alarm set point and at least 15 mm (1/2 inches) below auxiliary low water cutoff set point.

- c. Control system shall automatically modulate an electric feedwater flow control valve. Feedwater pump will operate continuously.
 - d. Gauge Glass and Gauge Valves: Single vertical flat gauge glass, tempered borosilicate, rated for 315 degrees C (600 degrees F). Provide automatic off-set gauge valves with ball checks to prevent fluid flow if gauge breaks. Provide carbon or stainless steel chamber, IFG-5500 Gaskets and cushions.
3. Auxiliary Water Column with Water Level Sensors for High and Low-Level Alarms and Auxiliary Low Water Cutoff:
- a. Conductivity probe type high and low-level alarm sensors and auxiliary low water cutoff sensor.
 - b. UL listed, factory-built probe and chamber unit mounted externally from the boiler.
 - c. Stainless steel conductivity probes and grounding probe. Virgin Teflon insulation.
4. Water columns shall be rated for 1380 kPa (200 psig) minimum saturated steam and have boiler and drain connections.
5. Water Column Piping to Boiler and to Drains: ASTM A106/A106M, Grade B, seamless or ERW piping, Schedule 80 threaded. Fittings shall be 300 lb. malleable iron or forged steel. All changes in direction shall be with crosses, no ells. Provide valved drain piping connected to the lowest part of each of the water columns.
6. Electrical: Provide circuit breakers, transformers, all devices for complete control system. All control electronics and relays shall be in waterproof NEMA 4 panels.
7. Modulating Feedwater Control Valve:
- a. Characterized rotary or sliding gate valve. Operated by electric drive unit actuator with top mount integrated digital positioner. Equal-percent valve flow characteristics. Modified linear valve flow characteristics shall be utilized when digital positioner is furnished.
 - b. Performance: Refer to schedules on the drawings for pressure, temperature and flow requirements. Shut-off seat leakage less than 0.0001 percent of valve CV.
 - c. Rotary Valve: Three-piece carbon steel body, 316 stainless steel ball and stem, Polyfil seat, TFE coated stainless steel seal,

2070 kPa (300 psig) 138 degrees C (280 degrees F) minimum ratings. Flanged ends or wafer type for pipe sizes over 50 mm (2 inches), threaded ends for pipe sizes 50 mm (2 inches) and less.

- d. Sliding Gate Valve: Stainless steel body, head section, actuator springs valve stem and fixed disc. Tribaloy (STN2) self-aligning sliding disc. Carbon filled PTFE packing. Minimum ratings 2070 kPa (300 psig), 138 degrees C (280 degrees F).
 - e. Sound Levels: Conform to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
 - f. Electric Drive Unit for Rotary Valve: Shall have sufficient power to operate valve under all operating conditions. All parts of linkage between drive unit and valve shall be free-working, securely attached, and shall not distort under all operating conditions.
8. Shunt Switches for Primary Low Water Cutoff and Auxiliary Low Water Cutoff: Provide separate non-latching shunt switches for each of the low water cutouts to allow manual blowdown of water column without tripping burner. Locate each switch adjacent to the drain valve for the low water cutout that is affected by the switch.
 9. Low Water Cutout Operation: Manual reset of primary low water cutoff shall be combined with the burner management manual reset. The burner management system annunciator and associated alarm horn shall indicate the primary and auxiliary low water cutoff operation. The manual resets for primary and auxiliary low water cutoffs shall be separate, such that an operator would be alerted to a failure of the primary cutoff.
- E. Stack Thermometer:
1. Dial-type, bi-metal element, stainless steel case and stem, adjustable angle, one percent of full scale accuracy, dual scale, 100 to 550 °C and 200 to 1000 °F, minimum diameter 125 mm (5 inches).
 2. Electronic temperature sensor with stainless steel sheath, for indication at the BAS.
- F. High Steam Pressure Burner Cutouts:
1. Provide two UL listed, FM approved units with different set points. Unit with lowest set point shall be automatic reset; unit with highest set point shall be manual reset.

2. Bellows or bourdon tube actuated sealed snap-acting switch with adjustable set point and adjustable differential pressure (automatic reset unit); switch position indicator.
3. Rated for 1380 kPa (200 psig) minimum emergency pressure.
4. Set pressure range: To 150 percent of required set pressure.
5. Provide indicators with graduated scales for set point and differential pressure.
6. Mounting: Connect to water column piping. There shall be no valves between cutoff and boiler shell. Provide siphons at each switch to protect bellows from high temperature.
7. Set Points:
 - a. Automatic Reset Unit: Refer to boiler schedule shown on the drawings. If not shown, set at 34 kPa (5 psig) below the set pressure of the manual reset unit.
 - b. Manual Reset Unit: 34 kPa (5 psig) below lowest safety valve set pressure. Subtractive differential not to exceed 69 kPa (10 psig).
8. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT for the operation of the cutouts.

2.3 BURNER AND FUEL TRAINS

- A. Burner Type: Integral combination natural gas and synthetic natural gas (propane air mix)., packaged, forced draft, modulating firing, and variable speed forced draft fan. Design for low NOx emissions. Burner shall be manufactured and tested by the boiler manufacturer on the boiler specified herein.
 1. Gas Burner: Ring type with multiple ports or spuds.
 2. Igniter (Pilot): Interrupted, electrically ignited, natural gas and propane air mix.
 3. Change of fuels will not require any disassembly and reassembly of the fuel train on burner fuel nozzles.
- B. Service:
 1. Continuous operation at all firing rates on each fuel listed under paragraph, PROJECT CONDITIONS of this Section. Design the entire burner and fuel train system for application to the specific boiler furnished and for service at the available fuel pressures.
 2. Igniter (Pilot) Fuels: Normal fuel will be natural gas.

3. Main Fuels: Natural gas with propane air mixture creating synthetic natural gas as emergency back up.

C. Performance:

1. Igniter (pilot) flame on natural gas shall form close to the point of ignition and shall be stable.
2. Main flame on gas shall ignite at lowest firing rate.
3. Main flame characteristics at all firing rates:
 - a. Flame retained at the burner.
 - b. Flame stable with no blowoff from the burner or flashback into the burner. Pulsations, rumble, or vibrations are prohibited at any firing rate.
 - c. No deposits of unburned fuel or carbon at any location.
 - d. No carryover of flame beyond the end of the first pass (furnace tube).
 - e. Steady constant direct contact or impingement of the flame on any surface is prohibited.
4. Main Burner Operation:
 - a. Minimum turndown 8:1.
 - b. Operate at all loads on any one fuel without any manual changes to burners, fuel trains or fuel pressures or pressures.
 - c. Excess Air in Flue Gases with Oxygen Trim at Null Position:

Boiler Steam Output, Percent of Maximum Required Capacity	Percent Excess Air Allowable Range
Below 25	15 minimum
25 to 39	15 to 35
40 to 100	15 to 25

- d. Performance at any load point shall be repeatable after increasing or decreasing the firing rate. Repeatability plus or minus five percent excess air, at 25 percent and higher boiler loading except excess air must remain within ranges specified above.
- e. Oxygen trim control set at maximum position shall not blow out the fire at any load point. At minimum position, the combustion shall not go below stoichiometric.

- f. Noise and Vibration: Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT for requirements on forced draft fan system. Burners shall operate without pulsation.
5. Flue Gas Emissions Limits:
- a. Carbon Monoxide: Shall not exceed 200 ppm.
 - b. Smoke: On natural gas and propane air mixture shall not be visible and shall not exceed No. 1 on the Bacharach smoke scale.
 - c. NOx: 30 ppm maximum, corrected to 3 percent oxygen, dry basis on natural gas and propane air mixture.
 - d. Burner and Fuel Systems Must meet EPA and Wyoming Department of Environmental Quality (WDEQ) emissions standards for type and size of boiler to be provided. At minimum it shall meet WDEQ standards for Opacity, CO, SOx, NOx, PM, PM 2.5, and PM 10. Notify VA if emissions standards are expected to change. Testing shall be performed in compliance with, and shall meet EPA and WDEQ air quality emissions permit requirements prior to acceptance of boiler by VA. Contractor shall submit professionally prepared WDEQ Air Quality Emissions permit application for the boilers to be provided to the VA for submission to WDEQ prior to the start of construction. Contractor shall pay WDEQ for Emissions permit application review as required for final air quality emissions permit of boilers provided.
- D. Construction:
- 1. Burner Access (Main Burner and Igniter): Arrange fuel valve and piping trains, controls and other devices so that they do not interfere with the removal and replacement of burner parts.
 - 2. Arrangement of Fuel Valve and Piping Trains: All devices shall be accessible for maintenance or replacement without removal of other devices. Do not attach any piping or devices to boiler casings.
 - 3. Coatings: Provide surface preparation, heat resistant prime and two finish coats using standard color of boiler manufacturer.
 - 4. Combustion Air System and Flue Gas Recirculation (FGR) System (if provided):
 - a. Air flow rates controlled by forced draft fan inlet or outlet dampers and variable speed drive.

- b. Symmetrical, balanced distribution of combustion air into the burner.
 - c. Provide induced type FGR system if FGR is necessary to achieve specified NOx limits. All FGR ductwork shall comply with Section 23 51 00, BREECHINGS, CHIMNEYS, AND STACKS.
 - d. Forced Draft Fan: Airfoil or backwardly inclined wheel, electric motor driven. Design for required excess air and for static pressure that is based on losses from fan inlet to stack or chimney outlet, including economizer (if provided), at jobsite altitude. Fan shall have no resonant frequencies at all operating speeds.
 - e. Motor: TEFC or open drip proof, non-overloading under all fan operating conditions, design for 40 degrees C (104 degrees F) ambient, premium efficiency type. Motors for variable speed service shall be rated inverter-ready. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
 - f. Damper: Design to provide accurate control of excess air with minimum hysteresis. On variable speed systems, the damper shall operate across all firing rates.
 - g. Motor Starter Panel: Provide motor starter and variable speed drive mounted in NEMA 4 enclosure, readily accessible. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT, for burner management system motor power interlocks.
 - h. Sound Attenuators: Provide attenuators on forced draft air intakes to reduce sound levels to allowable limits. Refer to Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
5. Provide front and rear viewports, with one clear and one tinted replaceable interchangeable glass. Locate to permit view of main and igniter flames.
 6. Burner Throat: Refractory tile, shaped to promote proper combustion, arranged with provisions for expansion and contraction and rated by the refractory manufacturer for the maximum service conditions.
 7. Electrical Conduit: Provide liquid-tight flexible metal conduit with sealing fittings for all power and control services to fuel trains

and burners. Flexible metal conduit must be limited to 900 mm (3 feet) in length, unless additional length is required for door or burner swing. Refer to Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

8. Factory Testing: Mount burner and controls on boiler at factory and fire-test to verify proper operation, including Flame Safeguard and safety interlock operation.

E. Natural Gas Main Fuel Train:

1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. Starting at the entrance to the train, the devices are, in sequence: plug valve, filter, pressure gauge, pressure regulator, valved connection to pilot burner fuel train, flow meter, pressure gauge, low pressure switch, two automatic safety shut off valves, valved leak test, high pressure switch, fuel flow control valve, plug valve, pressure gauge, burner. Provide tee connection for vent between the automatic safety shut off valves. Vent line shall include valved leak test connection, automatic vent valve, valved leak test connection, lockable plug valve, vent thru roof. High and low pressure switches shall be located to sense the constant pressure controlled by the burner pressure regulator and not the variable burner pressure.
2. Filter: Replaceable fiberglass or cellulose cartridge, 10 micron or smaller particle retention. Static pressure capability two times the maximum lock-up pressure of nearest upstream pressure regulator. Maximum pressure loss at high fire 1.3 kPa (5 inches WG). Provide vent with cock for relieving pressure in filter.
3. Pressure Regulator:
 - a. Single seated, diaphragm-operated, designed for natural gas service. Controlled pressure shall be sensed downstream of main valve. Valve may be self-operated or pilot-operated as necessary to comply with performance requirements.
 - b. Service: Provide precisely controlled downstream pressure in fuel train, as required by burner and fuel trains furnished, with upstream pressure as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lock-up pressure of the nearest upstream pressure regulator.

- c. Performance: Maximum outlet pressure drop 5 percent of the set pressure over the burner firing range. Maximum lock-up pressure 1.5 times regulated pressure. Speed of response to opening of automatic safety shut off valves shall be sufficient to allow set pressure of low pressure switch to be within 20 percent of the normal operating pressure with no nuisance burner trips.
 - d. Construction, Main Valve: Cast iron body, replaceable plug and seat. Downstream pressure-sensing line.
4. Automatic Safety Shut-Off Valves:
- a. Type: Motorized-opening, spring closing, controlled by burner control system. Two valves required.
 - b. Service: Provide open-shut control of fuel flow to burner. Valves shall shut bubble tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators.
 - c. Performance: Timed opening of six seconds or less to safely and smoothly ignite main flame, and close within one second.
 - d. Construction: Valves 65 mm (2-1/2 inches) and greater, flanged ends; valves 50 mm (2 inches) and less threaded ends; position indicator showing open and shut, visible from front or side of boiler. Aluminum seating surfaces are prohibited. Closed position interlock switch on each valve. Valved leak test fittings before and after each valve.
 - e. Approval: FM approved, UL listed for burner service.
 - f. Proof of Closure Test: Provide non-latching push button controls in the proof of closure circuit to interrupt the circuit when the valves are closed. Maxon or approved equal valve.
5. Automatic Vent Valve:
- a. Type: Motorized or solenoid closing, spring opening, full port, controlled by burner control system.
 - b. Service: Provide open-shut control of vent line that is connected between the two-safety shut-off valves. Valves shall shut bubble-tight and be suitable for operation with upstream pressure of two times the highest pressure at entrance to boiler-mounted regulators. Valve shall be open whenever safety shut-off valves are closed.

- c. Approval: UL listed for burner service.
- 6. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections between automatic vent valve and plug valve and ahead of the automatic vent valve.
- 7. Pressure Switches: Refer to paragraph, BURNER MANAGEMENT (FLAME SAFEGUARD CONTROL) SYSTEM WITH SAFETY INTERLOCKS AND ACCESSORIES in Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. Switch settings must be within 20 percent of the controlled pressure. High pressure switches shall have lockable service isolating valves and valved connections for pressurizing the switches and testing the set and trip points.
- 8. Fuel Flow Control Valve:
 - a. Type: Throttling, controlled by combustion control system. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
 - b. Performance and Service: Control fuel flow in exact proportion to combustion airflow over the entire firing range of the burner. Static pressure rating shall exceed the lockup pressure of the boiler-mounted regulator.
 - c. Valve Requirement for Single Point Positioning Jackshaft Control Systems: Valve shall have adjustable characterization cam shaped by at least twelve adjustment screws.
 - d. Gas turn down capability shall be a minimum of 4:1 for boilers up to 2 MW (200 hp) and 10:1 from 2.45 MW (250 hp) and above.
- 9. Pressure Gauges, Flow Meter: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- F. Igniter (Pilot) Fuel Train, Burner and Ignition System:
 - 1. Arrangement: Comply with typical arrangement in NFPA 85, Annex A, as modified by the following description. The system shall automatically match the selection of either natural gas or propane-air mix for the ignition fuel based on the main fuel selected. Provide piping with plug valve, pressure gauge, filter and pressure regulator. Connect to the main burner natural gas service downstream

- of the main burner pressure regulator. Continue with one pipe line including a low pressure switch, pressure gauge, automatic safety shut off valve, automatic vent, automatic safety shut off valve, igniter.
2. Filters: Replaceable elements, five micron or smaller particle retention. Static pressure capability two times the maximum lockup pressure of nearest upstream pressure regulator. Maximum pressure loss, at full flow, 1.3 kPa (5 inches WG). Provide unions for filter removal.
 3. Pressure Regulators:
 - a. Type: Single-seated, diaphragm-operated.
 - b. Service: Provide controlled pressure in igniter train as required by igniter, with upstream pressures as shown or specified. Inlet and outlet emergency pressure rating shall be at least twice the lockup pressure of the nearest upstream pressure regulator. As an alternate to the outlet emergency pressure rating, provide internal relief valve vented to outside set at pressure that will avoid overpressure on regulator outlet that could damage the regulator.
 - c. Performance: Lockup pressure shall not exceed 1.5 times the regulated pressure.
 4. Automatic Safety Shut-Off and Vent Valves:
 - a. Type: Solenoid-type, two normally closed shut-off valves and one normally-open vent valve, arranged as shown, controlled by the burner control system. Provide threaded leak-test ports with threaded plugs on each shut-off valve body.
 - b. Service: Provide open-shut control of fuel flow to igniter and vent between shut-off valves. Design for 138 kPa (20 psig) differential at shut-off.
 - c. Approval: Safety shut-off valves UL listed, FM approved for burner service. Vent valves UL listed for burner service.
 5. Vent System Manual Plug Valve for Leak Tests: Located on vent line on outlet side of automatic vent valve. Provide locking device and lock wrench to lock valve to open position. Provide cylinder padlock keyed to VA Engineering key. Provide valved leak test connections

between automatic vent valve and plug valve and ahead of the automatic vent valve.

6. Igniter and Ignition System: Provide removable igniter, ignition electrodes, ignition transformer, high voltage cable. Provide shield at ignition area so that spark is not visible to flame scanner from any position on its mounting.
7. Igniter fuel train pipe and fittings: ASME B31.1 requirements do not apply. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
8. Pressure Switch and Pressure Gauges: Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.

2.4 BURNER MANAGEMENT AND FLAME SAFEGUARD CONTROL SYSTEMS AND ACCESSORIES

- A. Provide in accordance with NFPA 85.
- B. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
- C. Control Panel: Controls shall be mounted in NEMA 4 enclosure on side of boiler or on burner. There shall be no power wiring in this enclosure.
- D. Factory Testing: Install controls on boiler and burner at factory and test operation of all devices.

2.5 FLUE GAS ECONOMIZER

- A. Heat exchangers to transfer heat from boiler flue gases to boiler feedwater.
- B. Type: Rectangular configuration, replaceable finned tubes, up flow flue gas, **parallel flow water**, insulated casing with removable panels allowing access to all tubes for cleaning and replacement.
- C. Performance: Refer to schedules on drawings. Coordinate input flue gas temperatures with data from boiler manufacturer.
- D. Construction:
 1. Comply with ASME BPVC Section VIII. Design unit to permit operation with no water in the tubes at the temperature listed below.
 2. Design Pressure:
 - a. Water Tubes, 2070 kPa (300 psig) minimum.
 - b. Inner Casings, 2.5 kPa (10 inches WG) minimum.
 3. Design Temperature, 371 degrees C (700 degrees F).
 4. Tubes and Headers: ASTM A254, Type 316 Stainless steel. Helically wound non-serrated stainless steel fins continuously welded to tubes. 2070 kPa (300 psig) flanged piping connections. Drainable by

- gravity. Return bend areas shall be exposed to the bulk temperature of the flue gas. Headers shall be external to the casing. Fin density shall not exceed 157 fins per meter (48 fins per foot). Maximum fin height, 15 mm (1/2 inches).
5. Casing: Double wall, removable panels, with insulation between walls. 75 mm (3 inch) angle flanges on flue gas inlet and outlet for attachment of breeching and stack.
 - a. Inner Casing, stainless steel, all welded. Steel angles for breeching attachment to casing. Entire casing systems must be gas tight.
 - b. Insulation: Mineral fiber, ASTM C612, 50 mm (2 inches) thick.
 - c. Outer Casing: Galvanized or painted steel, 0.4 mm (0.016 inches) thick.
- E. Accessories:
1. Safety Relief Valve: Valve designed for steam and water service, ASME National Board certified, selected by economizer manufacturer in accordance with ASME Code requirements. Set pressure 1896 kPa (275 psig) gauge.
 2. Inlet and Outlet Transitions: Designed and furnished by economizer manufacturer.
- F. Factory Test and Inspections: Inspect the completed economizer assembly in accordance with the ASME BPVC Section I. Certify the inspection and submit four copies of completed ASME Form P-3 for each economizer.

2.6 TOOLS

- A. Boiler Tube Brushes: Furnish hand brushes of sizes, and with handle lengths, to clean full length of all tubes in boiler. Provide handle and extension sections 1800 mm (6 feet) long or less to permit storage. Coupled lengths shall be suitable for use from front of boiler.

2.7 SPARE PARTS

- A. Fuel Trains:
1. One of each type and size of main and pilot fuel motorized and solenoid automatic safety shut-off valves and automatic vent valves.
 2. Complete set of filter elements and gaskets for each gas filter for each boiler.

B. Boiler, Burner, Trim, Feedwater Control System:

1. One assembly of electrodes, transformer, and high voltage lead with end connectors for igniters.
2. Two complete sets of gaskets, for each boiler, to fit all doors, handholes, manholes.
3. One clear lens and one tinted lens for each furnace and burner observation port on each boiler.
4. Sufficient tubular glass inserts and gaskets to re-equip water level gauge glasses on each boiler.
5. One set of drive belts for each belt-driven apparatus for each boiler.
6. Complete set of air compressor intake filter elements for each compressor, for each boiler, if disposable filters are provided.
7. One complete feedwater control valve and actuator.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Boiler and Burner Access Openings: Arrange all equipment and piping to allow access to openings without disassembly of equipment or piping. Provide space that permits full opening of all boiler and burner doors, panels and other access openings. Provide space for pulling full length of all boiler tubes directly from their installed location.
- C. Drainage Facilities for Boiler Water Column, Gauge Glass, Low Water Cutoffs, Water Level Alarms:
 1. Refer to Detail, FIRE TUBE BOILER.
 2. Locate and orient sight flow indicators so that one person can view the fluid flow while simultaneously operating drain valves and low water cutoff shunt switches.
- D. Boiler Flue Gas Outlet Location: Drawings show a location based on an assumption on the number of passes of the boilers. If the boilers submitted have a different flue gas outlet location, redesign and relocate the stack and breeching systems, at no additional cost or time to the Government.

- E. Boiler Casing Flashing: Flash or seal all openings in the casing at the top of the boiler at the piping and the flue penetrations to prevent leakage of water into the boiler insulation.

3.2 CLEANING AND PROTECTION FROM CORROSION

- A. Refer to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- B. Boiler Cleaning:
 - 1. Upon completion of installation, the initial firing of the burner shall be performed to boil out, under supervision of boiler manufacturer, all internal surfaces with chemical solution recommended by boiler manufacturer, to remove all mill scale, corrosion products and other foreign material. Following boil out, boiler shall be washed and flushed until water leaving the boiler is clear. Drain boiler, inspect internal surfaces for cleanliness, then refill boiler with softened and treated water.
 - 2. Refer to the paragraph, INSPECTIONS AND TESTS for requirements for cleaning boiler after operational tests are completed.
- C. Protection from Corrosion:
 - 1. Protect the boilers from fire-side and water-side corrosion at all times.
 - 2. Dry Storage: When the boilers are not filled with water, protect the water-sides and fire-sides with a dry storage method recommended by either the boiler manufacturer or the ASME BPVC Section VII.
 - 3. Wet Storage: If, after water is placed in the boilers, they are not fired for equipment adjustment or testing for more than two weeks, the boilers shall be protected with a wet storage method recommended either by the boiler manufacturer or the ASME BPVC Section VII.
 - 4. Chemical Treatment: The quality of the water in the boilers shall be maintained by a professional water treatment organization. This organization shall provide onsite supervision to maintain the required water quality during periods of boiler storage, operating, standby and test conditions. Furnish monthly reports by the water treatment organization, to the COR. The Contractor shall provide all chemicals, labor and professional services until the boilers have been accepted by the Government for operation. All chemicals

utilized must conform to FDA Regulation CFR 21, 173.310, guidelines applicable for steam used in food preparation.

3.3 INSPECTIONS AND TESTS

- A. The following tests and demonstrations must be witnessed by the COR or his/her representative, and must prove that boilers, economizers, burners, controls, instruments, and accessories comply with requirements. Refer to Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT for general requirements. When test results are not acceptable, make corrections and repeat tests at no additional cost or time to the Government. All safety devices shall be tested in accordance with the VHA Boiler Plant Safety Devices Testing Manual and all construction documents. The VA will not take beneficial use of equipment until all safety devices pass the required tests. Pretests do not require the presence of the COR. Evidence of the tests shall include completed sign-in sheet and test checklists from the VHA Boiler Plant Safety Devices Testing Manual, which shall be filled out completely for all equipment that has been provided by, or directly or indirectly affected by, the project.
- B. Manufacturer Certification at Start-Up: The boiler manufacturer shall certify that the equipment furnished has been installed, connected, and tested in accordance with the manufacturer's installation and operating instructions.
- C. Condition of Boiler and Economizer After Delivery, Rigging, Placement: After setting boiler on foundation and placing economizer on supports, and prior to making any connections to boiler and economizer, the Contractor and COR shall jointly inspect interior and exterior for damage. Correct all damage by repair or replacement to achieve a like new condition.
- D. Hydrostatic Tests:
1. Boiler, Economizer: Contractor shall provide inspector certified by National Board of Boiler and Pressure Vessel Inspectors (NBBI) to conduct tests after equipment is installed and connected for operation and prior to initial firing. Test pressure shall be 1-1/2 times the design pressure of the boiler for a period required by the inspector. Provide written certification of the satisfactory test, signed by the inspector. Correct any deficiencies discovered during

the testing, and retest equipment until satisfactory results are achieved and are accepted by the inspector. The COR or his/her representative shall be present for inspections and tests.

2. Boiler External Piping (as defined by ASME B31.1):
 - a. Refer to Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
 - b. Test may be conducted concurrently with boiler and economizer testing.
3. Identify and remove any connecting equipment which is not rated for the test pressure. Cap the openings left by the disconnected equipment. Reinstall the equipment after tests are completed.

E. Boiler Steam Safety Valves:

1. Test each valve set pressure and blowdown pressure with boiler steam pressure. Perform accumulation test by operating burner at high fire to verify that safety valve flow capacity is sufficient to handle the maximum boiler steaming rate. Tests shall be performed with boiler isolated from the main steam header and all generated steam exhausting through the safety valves.
2. Valve Popping Tolerance: Plus or minus three percent of set pressure for set pressures over 480 kPa (70 psig) gauge.
3. Valve Blowdown Tolerance: Reset at not less than 6 percent below set pressure of valve with the lowest set pressure. Minimum blowdown two percent of the set pressure.
4. Accumulation Test: With burner at high fire, the boiler pressure shall not rise more than six percent above the set pressure of the safety valve with highest pressure setting and shall remain below the maximum allowable working pressure of the boiler.

F. Burner Management (Flame Safeguard Control) System:

1. Demonstrate operation of all control, interlock and indicating functions. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
2. Prior to scheduling final test submit certification that all control, indicating, and interlock functions have been pretested.
3. Conduct final test immediately prior to boiler-burner tests.
4. Experienced personnel representing the manufacturer of the system shall conduct the tests.

G. Performance Testing of Boiler, Burner, Economizer (if provided),
Combustion Control, Boiler Plant Instrumentation:

1. Perform tests on each boiler on all main burner fuels.
2. If required by local emissions authorities, provide services of testing firm to determine NOx and carbon monoxide. Test firm shall be acceptable to emissions authorities.
3. Test No. P-1:
 - a. Operate boiler on each fuel, with economizer (if provided) in service and record data for at least eight evenly spaced steam loads from low fire start to 100 percent of full steam output, and in the same sequence back to low fire. Demonstrate performance and efficiency required by paragraphs, BOILER, BURNER AND FUEL TRAINS, and FLUE GAS ECONOMIZER and by boiler and economizer equipment lists on drawings.
 - b. Demonstrate proper operation of combustion controls, draft control (if provided), feedwater level controls, and instrumentation systems. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT.
 - c. When flue gas oxygen trim is provided, conduct tests with trim control on manual at the zero trim (null) position. Refer to Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT. After completion of tests with trim control on manual control, repeat the tests on one fuel with the trim control on automatic control.
4. Test No. P-2:
 - a. Demonstrate sound level of fans and burner systems.
 - b. Test point shall be at 100 percent of maximum boiler load.
 - c. Refer to sound level requirements in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT.
5. Test No. P-3:
 - a. Check current draw of forced draft fan motor at prepurge and at 100 percent of maximum boiler load.
 - b. Current draw shall not exceed full load current stamped on motor nameplate.
 - c. This test may be combined with Test No. P-1.

6. Test Methods:

- a. Utilize permanent instrumentation systems for data. All systems shall be operable and in calibration.
- b. Utilize portable thermocouple pyrometer furnished and retained by Contractor to measure stack temperature as a verification of permanent stack temperature recorder.
- c. Use portable electronic flue gas analyzer to determine constituents of flue gas. Analyzer shall be capable of measuring oxygen in per cent with accuracy of plus or minus 0.5 percent oxygen and carbon monoxide in ppm with accuracy of plus or minus 5 percent of reading (Range 0 to 1000 ppm). Obtain oxygen and carbon monoxide readings at each test point. Calibrate instrument with certified test gases within three months prior to use and immediately after analyzer cell replacement.
- d. In Test No. P-1 retain boiler at each load point for a time period sufficient to permit stabilization of flue gas temperature and other parameters.
- e. Steam loads for tests may be furnished by the hospital systems, by operation of the steam silencer vent system, or by a combination of the above. If variable hospital loads interfere with testing, conduct tests at night or on weekends when loads are more stable.
- f. Utilize dry bulb and wet bulb thermometers furnished and retained by Contractor for checking combustion air.
- g. Smoke testing shall be by visual observation of the stack and by smoke density monitor (permanent instrument - if provided). If smoke density monitor is not provided, utilize Bacharach Model 21-7006 Smoke Test Kit. If there is disagreement with the results of these tests, provide qualified observation person and tests in compliance with EPA Reference Method 9 (CFR 40, Part 60, Appendix A).
- h. Sound level instruments will be Government furnished.
- i. NO_x emissions shall be tested with electronic analyzer reading in ppm. Analyzer shall be calibrated with certified test gas within three months prior to use. Analyzer shall be accurate to plus or minus 5 percent of reading.

- j. An additional efficiency test will be required, conforming to ASME PTC 4, if the boiler efficiency determined in the Test P-1 above, does not comply with requirements. Utilize ASME Test Forms and the abbreviated input-output and heat balance methods.

7. Pretesting:

- a. Perform pretest at the final stage of the burner fine-tuning process.
- b. Prior to scheduling final test, submit evidence of pretest. Evidence shall consist of start-up data sheets signed and dated by personnel representing burner manufacturer, combustion controls manufacturer, burner controls manufacturer. Evidence of the tests shall also include completed sign-in sheet and test checklists from the VHA Boiler Plant Safety Devices Testing Manual, which shall be filled out completely for all equipment that has been provided by, or directly or indirectly affected by, the project.
- c. Pretest data sheets shall list the following data for each fuel and at each fuel valve controller position, starting at minimum position, proceeding to the maximum position and returning to the minimum position.
 - 1) Fuel flow and air flow controller position.
 - 2) Fuel pressures: At burner and also upstream of fuel flow control valve.
 - 3) Fuel flow rate.
 - 4) Boiler feed pressure, upstream of feedwater regulator (at minimum, 50 percent, maximum firing positions only).
 - 5) Boiler feed temperature (at minimum, 50 percent, maximum firing positions only).
 - 6) Stack temperature: Boiler outlet, economizer (if provided) outlet.
 - 7) Flue gas oxygen and carbon monoxide (utilize flue gas analyzer which has been calibrated with certified test gases).
 - 8) Steam flow rate (at minimum, 50 percent, maximum firing position only).
 - 9) Steam pressure - Boiler, Header (at minimum, 50 percent, maximum positions only).

- 10) Opacity of flue gas.
- 11) Flue gas NO_x (if limit specified).
- 12) Combustion air temperature - dry bulb and wet bulb.
- 13) Barometric pressure (one reading).

d. Calibrate all pressure gauges prior to pretest.

H. Internal Inspection of Pressure Parts and Furnace:

1. After all operational tests are satisfactorily completed, a Government retained, licensed boiler inspector will determine if the boiler is free from corrosion, deposits, and any other type of damage or defect.
2. In preparation for the inspection, open all manways, handholes, and access doors or panels at the ends of the boiler. Drain and clean the interior of all pressure parts and clean all soot and debris from furnace and fire tubes.
3. Any corrosion, damage or defect shall be corrected to a like new condition in the judgment of the boiler inspector.
4. After the boiler inspector has approved the boiler, all manways, handholes, and the access doors shall be closed with new gaskets.

I. If burner operation results in deposits of carbonaceous materials in the furnace or tubes clean the furnace and tubes, modify the burners as necessary, and retest the burner performance and safety devices, as the safety device settings can be affected by burner adjustments.

J. Any retests required as a result of failed tests shall be performed at no additional cost to the Government. Costs incurred by the Government as a result of witnessing failed tests shall become the responsibility of the contractor, and the Government may choose to withhold contract payment equal to the value of such costs.

3.4 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.5 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for 72 hours to instruct each VA personnel responsible in the operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -

SECTION 26 05 11**REQUIREMENTS FOR ELECTRICAL INSTALLATIONS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section 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, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on the drawings.
- C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system and obtain electric utility company approval for sizes and settings of these devices.
- D. 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 latest International Building Code (IBC), Underwriters Laboratories, Inc. (UL), Institute of Electrical and Electronics Engineers (IEEE), 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 who's 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.
5. Shall: Mandatory by contractor.

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.
 2. The Government reserves the right to require the Contractor to submit a list of installations where the materials and equipment have been in operation before approval.
- C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

- A. Applicable publications listed in all Sections of Division 26 shall be 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. Materials and equipment furnished shall be new and shall have superior quality and freshness.
- 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.

- E. When Factory Tests are specified, Factory Tests shall be performed in the factory by the equipment manufacturer and witnessed by the contractor. In addition, the following requirements shall be complied with:
1. The Government shall have the option of witnessing factory tests. The Contractor shall notify the Government through the COR a minimum of thirty (30) days prior to the manufacturer's performing of the factory tests.
 2. When factory tests are successful, contractor shall furnish four (4) copies of the equipment manufacturer's certified test reports to the COR fourteen (14) days prior to shipment of the equipment, and not more than ninety (90) days after completion of the factory tests.
 3. When factory tests are not successful, factory tests shall be repeated in the factory by the equipment manufacturer and witnessed by the Contractor. The Contractor shall be liable for all additional expenses for the Government to witness factory re-testing.

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 requirements of the latest NFPA 70 (NEC), NFPA 70B, NFPA 70E, NFPA 99, NFPA 110, 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. However, energized electrical work may be performed only for the non-destructive and non-invasive diagnostic testing(s), or when scheduled outage poses an imminent hazard to patient care, safety, or physical security. In such case, all aspects of energized electrical work, such as the availability of appropriate/correct personal protective equipment (PPE) and the use of PPE, shall comply with the latest NFPA 70E, as well as the following requirements:
 1. Only Qualified Person(s) shall perform energized electrical work. Supervisor of Qualified Person(s) shall witness the work of its entirety to ensure compliance with safety requirements and approved work plan.
 2. At least two weeks before initiating any energized electrical work, the Contractor and the Qualified Person(s) who is designated to perform the work shall visually inspect, verify and confirm that the work area and electrical equipment can safely accommodate the work involved.
 3. At least two weeks before initiating any energized electrical work, the Contractor shall develop and submit a job specific work plan, and energized electrical work request to the COR, and Medical Center's Chief Engineer or his/her designee. At the minimum, the

- work plan must include relevant information such as proposed work schedule, area of work, description of work, name(s) of Supervisor and Qualified Person(s) performing the work, equipment to be used, procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used, and exit pathways.
4. Energized electrical work shall begin only after the Contractor has obtained written approval of the work plan, and the energized electrical work request from the COR, and Medical Center's Chief Engineer or his/her designee. The Contractor shall make these approved documents present and available at the time and place of energized electrical work.
 5. Energized electrical work shall begin only after the Contractor has invited and received acknowledgment from the COR, and Medical Center's Chief Engineer or his/her designee to witness the work.
- 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.

- D. Electrical service entrance equipment and arrangements for temporary and permanent connections to the electric utility company's system shall conform to the electric utility company's requirements. Coordinate fuses, circuit breakers and relays with the electric utility company's system and obtain electric utility company approval for sizes and settings of these devices.

1.11 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers, fused and non-fused safety switches, generators, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.
- B. 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 the latest NFPA 70E. Label shall show specific and correct information for specific equipment based on its arc flash calculations. Label shall show the followings:
1. Nominal system voltage.
 2. Equipment/bus name, date prepared, and manufacturer name and address.
 3. Arc flash boundary.
 4. Available arc flash incident energy and the corresponding working

distance.

5. Minimum arc rating of clothing.
6. Site-specific level of PPE.

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. 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. Maintenance and Operation Manuals:

1. Submit as required for systems and equipment specified in the technical sections. Furnish in hardcover binders or an approved equivalent.
 2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, material, equipment, building, name of Contractor, and contract name and number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the material or equipment.
 3. Provide a table of contents and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
 4. The manuals shall include:
 - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
 - b. A control sequence describing start-up, operation, and shutdown.
 - c. Description of the function of each principal item of equipment.
 - d. Installation instructions.
 - e. Safety precautions for operation and maintenance.
 - f. Diagrams and illustrations.
 - g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers.
 - h. Performance data.
 - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare and replacement parts, and name of servicing organization.
 - j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.
- G. Approvals will be based on complete submission of shop drawings, manuals, test reports, certifications, and samples as applicable.
- H. After approval and prior to installation, furnish the COR with one

sample of each of the following:

1. A minimum 300 mm (12 inches) length of each type and size of wire and cable along with the tag from the coils or reels from which the sample was taken. The length of the sample shall be sufficient to show all markings provided by the manufacturer.
2. Each type of conduit coupling, bushing, and termination fitting.
3. Conduit hangers, clamps, and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, lighting control sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

- 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 POLYCHLORINATED BIPHENYL (PCB) EQUIPMENT - (NOT USED)

1.15 ACCEPTANCE CHECKS AND TESTSACCEPTANCE 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 for the equipment. Repair, replacement, and re-testing shall be accomplished at no additional cost to the Government.

1.16 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.

1.17 INSTRUCTION

- A. Instruction to designated Government personnel shall be provided for the particular equipment or system as required in each associated technical specification section.
- B. Furnish the services of competent and factory-trained instructors to give full instruction in the adjustment, operation, and maintenance of the specified equipment and system, including pertinent safety requirements. Instructors shall be thoroughly familiar with all aspects of the installation and shall be factory-trained in operating theory as well as practical operation and maintenance procedures.
- C. A training schedule shall be developed and submitted by the Contractor and approved by the COR at least 30 days prior to the planned training.

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. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 2. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the Contractor that the conductors and cables have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are 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):
- 70-17.....National Electrical Code (NEC)
- E. Underwriters Laboratories, Inc. (UL):
- 44-14.....Thermoset-Insulated Wires and Cables
- 83-14.....Thermoplastic-Insulated Wires and Cables
- 467-13.....Grounding and Bonding Equipment
- 486A-486B-13.....Wire Connectors
- 486C-13.....Splicing Wire Connectors
- 486D-15.....Sealed Wire Connector Systems
- 486E-15..... Equipment Wiring Terminals for Use with
Aluminum and/or Copper Conductors
- 493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cables
- 514B-12.....Conduit, Tubing, and Cable Fittings

PART 2 - PRODUCTS**2.1 CONDUCTORS AND CABLES**

- A. Conductors and cables shall be in accordance with ASTM, NEMA, NFPA, 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.
4. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

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.
3. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
4. 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.		

5. 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.
6. 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 No. 8 AWG to No. 4/0 AWG:
1. Compression, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, 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.
 4. All bolts, nuts, and washers used with splices shall be zinc-plated steel.
- D. Above Ground Splices for 250 kcmil 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.
- E. Underground Splices for No. 10 AWG and Smaller: - (NOT USED)
- F. Underground Splices for No. 8 AWG and Larger: - (NOT USED)
- G. Plastic electrical insulating tape: - (NOT USED)

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 zinc-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.
- B. Shall not be used on conductors for isolated power systems.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. Install all conductors in raceway systems.
- C. Splice conductors only in outlet boxes, junction boxes, pull boxes, 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 INSTALLATION IN MANHOLES - (NOT USED)

3.3 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.

3.4 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, pull boxes, 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.

3.5 FEEDER CONDUCTOR IDENTIFICATION

- A. In each interior pull box and each underground manhole and handhole, 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.

3.6 EXISTING CONDUCTORS

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

3.7 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.

3.8 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.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.9 DIRECT BURIAL CABLE INSTALLATION - (NOT USED)**3.10 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.
- D. Section 26 24 16, PANELBOARDS: Low-voltage panelboards.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
- B. Shop Drawings:
 - 1. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - 2. Submit plans showing the location of system grounding electrodes and connections, and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports:

1. Two weeks prior to the final inspection, submit ground resistance field test reports to the COR.

D. Certifications:

1. 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):

- B1-13.....Standard Specification for Hard-Drawn Copper Wire
- B3-13.....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):

- 81-12.....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):

- 70-17National Electrical Code (NEC)
- 70E-15National Electrical Safety Code
- 99-15Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

- 44-14Thermoset-Insulated Wires and Cables
- 83-14Thermoplastic-Insulated Wires and Cables
- 467-13Grounding 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.
- D. Insulation: THHN-THWN and XHHW-2. XHHW-2 shall be used for isolated power systems.

2.2 GROUND RODS - (NOT USED)

2.3 CONCRETE ENCASED ELECTRODE - (NOT USED)

2.4 GROUND CONNECTIONS

A. 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 zinc-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 zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
4. Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

- A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks. Ground bars shall have minimum dimensions of 6.3 mm (0.25 inch) thick x 19 mm (0.75 inch) wide, with length as required or as shown on the drawings. Provide insulators and mounting brackets.

2.6 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 zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.7 GROUNDING BUS BAR - (NOT USED)**PART 3 - EXECUTION****3.1 GENERAL**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. System Grounding: - (NOT USED)
- C. 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.
- D. For patient care area electrical power system grounding, conform to the latest NFPA 70 and 99. - (NOT USED)

3.2 INACCESSIBLE GROUNDING CONNECTIONS

- A. Make grounding connections, which are normally buried or otherwise inaccessible, by exothermic weld.

3.3 MEDIUM-VOLTAGE EQUIPMENT AND CIRCUITS - (NOT USED)**3.4 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. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control

Centers, Engine-Generators, Automatic Transfer Switches, 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.

D. Transformers: - (NOT USED)

3.5 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 an 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. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.
- G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- H. Raised Floors: Provide bonding for all raised floor components as shown on the drawings. - (NOT USED)
- I. 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.

3.6 OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT - (NOT USED)

3.7 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.

3.8 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.

B. In operating rooms and at intensive care and coronary care type beds, bond the medical gas piping and medical vacuum piping at the outlets directly to the patient ground bus.

3.9 LIGHTNING PROTECTION SYSTEM - (NOT USED)

3.10 MAIN ELECTRICAL ROOM GROUNDING - (NOT USED)

3.11 EXTERIOR LIGHT POLES - (NOT USED)

3.12 GROUND RESISTANCE - (NOT USED)

3.13 GROUND ROD INSTALLATION - (NOT USED)

3.14 ACCEPTANCE CHECKS AND TESTS

A. 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 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section 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.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Certifications: Two weeks prior to final inspection, submit the following:
 - a. Certification by the manufacturer that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment conform to the requirements of the drawings and specifications.

- b. Certification by the Contractor that raceways, conduits, conduit bodies, connectors, fittings, junction and pull boxes, and all related equipment have 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 Iron and Steel Institute (AISI):

100-12North American Specification for the Design of
Cold-Formed Steel Structural Members

C. National Electrical Manufacturers Association (NEMA):

C80.1-15ELECTRICAL RIGID STEEL CONDUIT

C80.3-15STEEL ELECTRICAL METAL TUBING

C80.6-05ELECTRICAL INTERMEDIATE METAL CONDUIT

FB1-14FITTINGS, CAST METAL BOXES AND CONDUIT BODIES
FOR CONDUIT, ELECTRICAL METALLIC TUBING AND
CABLE

FB2.10-13SELECTION AND INSTALLATION GUIDELINES FOR
FITTINGS FOR USE WITH NON-FLEXIBLE CONDUIT OR
TUBING (RIGID METAL CONDUIT, INTERMEDIATE
METALLIC CONDUIT, AND ELECTRICAL METALLIC
TUBING)

FB2.20-14SELECTION AND INSTALLATION GUIDELINES FOR
FITTINGS FOR USE WITH FLEXIBLE ELECTRICAL
CONDUIT AND CABLE

TC-2-13ELECTRICAL POLYVINYL CHLORIDE (PVC) TUBING AND
CONDUIT

TC-3-13PVC FITTINGS FOR USE WITH RIGID PVC CONDUIT AND
TUBING

D. National Fire Protection Association (NFPA):

70-17NATIONAL ELECTRICAL CODE (NEC)

E. Underwriters Laboratories, Inc. (UL):

1-05	.....FLEXIBLE METAL CONDUIT
5-16	.....SURFACE METAL RACEWAY AND FITTINGS
6-07	.....ELECTRICAL RIGID METAL CONDUIT - STEEL
50-15	.....ENCLOSURES FOR ELECTRICAL EQUIPMENT
360-13	.....LIQUID-TIGHT FLEXIBLE STEEL CONDUIT
467-13	.....GROUNDING AND BONDING EQUIPMENT
514A-13	.....METALLIC OUTLET BOXES
514B-12	.....CONDUIT, TUBING, AND CABLE FITTINGS
514C-14	.....NONMETALLIC OUTLET BOXES, FLUSH-DEVICE BOXES AND COVERS
651-11	.....SCHEDULE 40 AND 80 RIGID PVC CONDUIT AND FITTINGS
651A-11	.....TYPE EB AND A RIGID PVC CONDUIT AND HDPE CONDUIT
797-07	.....ELECTRICAL METALLIC TUBING
1242-14	.....ELECTRICAL INTERMEDIATE METAL CONDUIT - STEEL

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 19 mm (0.75-inch) unless otherwise shown. Where permitted by the NEC, 19 mm (0.75-inch) flexible conduit may be used for tap connections to recessed lighting fixtures.
- B. Conduit:
1. Size: In accordance with the NEC, but not less than 19 mm (0.75-inch).
 2. Rigid Steel Conduit (RMC): Shall conform to UL 6 and NEMA C80.1.
 3. Rigid Intermediate Steel Conduit (IMC): Shall conform to UL 1242 and NEMA C80.6.
 4. Electrical Metallic Tubing (EMT): Shall conform to UL 797 and NEMA C80.3. Maximum size not to exceed 105 mm (4 inches) and shall be permitted only with cable rated 600 V or less.
 5. Flexible Metal Conduit: Shall conform to UL 1.

6. Liquid-tight Flexible Metal Conduit: Shall conform to UL 360.
7. Direct Burial Plastic Conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
8. Surface Metal Raceway: Shall conform to UL 5.

C. Conduit Fittings:

1. Rigid Steel and Intermediate Metallic 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. Rigid Aluminum Conduit Fittings: - (NOT USED)
3. Electrical Metallic Tubing Fittings:
 - a. Fittings and conduit bodies shall meet the requirements of UL 514B, NEMA C80.3, and NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.
 - c. Compression Couplings and Connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
 - d. Indent-type connectors or couplings are prohibited.

- e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
4. Flexible Metal Conduit Fittings:
 - a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
 - b. Clamp-type, with insulated throat.
 5. 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.
 6. Direct Burial Plastic Conduit Fittings: Fittings shall meet the requirements of UL 514C and NEMA TC3.
 7. Surface Metal Raceway Fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
 8. Expansion and Deflection Couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 19 mm (0.75-inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
1. Parts and Hardware: Zinc-coat or provide equivalent corrosion protection.
 2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.

3. Multiple Conduit (Trapeze) Hangers: Not less than 38 mm x 38 mm (1.5 x 1.5 inches), 12-gauge steel, cold-formed, lipped channels; with not less than 9 mm (0.375-inch) 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. Comply with UL-50 and UL-514A.
 2. Rustproof cast metal where required by the NEC or shown on drawings.
 3. Sheet Metal Boxes: Galvanized steel, except where shown on drawings.
 - F. Metal Wireways: Equip with hinged covers, except as shown on drawings. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.

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 when permitted by the COR where working space is limited.
- 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, exterior wall, and roof conduit penetrations, completely seal the gap around conduit to render it watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

- A. In accordance with NEC, NEMA, UL, as shown on drawings, and as specified herein.

B. Raceway systems used for Essential Electrical Systems (EES) shall be entirely independent of other raceway systems.

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 conduits.
4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
5. Cut conduits square, ream, remove burrs, and draw up tight.
6. Independently support conduit at 2.4 M (8 feet) on centers with specified materials and as shown on drawings.
7. Do not use suspended ceilings, suspended ceiling supporting members, lighting fixtures, other conduits, cable tray, boxes, piping, or ducts to support conduits and conduit runs.
8. Support within 300 mm (12 inches) of changes of direction, and within 300 mm (12 inches) of each enclosure to which connected.
9. Close ends of empty conduits with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
10. Conduit installations under fume and vent hoods are prohibited.
11. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid steel 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.
12. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
13. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
14. Do not use aluminum conduits in wet locations.

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 and approved by the COR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:

1. Align and run conduit in direct lines.

2. 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.

3. Installation of conduit in concrete that is less than 75 mm (3 inches) 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 19 mm (0.75-inch) of concrete around the conduits.

4. 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 in the same system is prohibited.

2. Align and run conduit parallel or perpendicular to the building lines.

3. Connect recessed lighting fixtures to conduit runs with maximum 1.8 M (6 feet) of flexible metal conduit extending from a junction box to the fixture.
4. Tightening set screws with pliers is prohibited.
5. For conduits running through metal studs, limit field cut holes to no more than 70% of web depth. Spacing between holes shall be at least 457 mm (18 inches). Cuts or notches in flanges or return lips shall not be permitted.

3.4 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on 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 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 2.4 M (8 feet) intervals.
- F. Surface Metal Raceways: Use only where shown on drawings.
- G. Painting:
 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (2 inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6 M (20 feet) intervals in between.

3.5 DIRECT BURIAL INSTALLATION - (NOT USED)

3.6 HAZARDOUS LOCATIONS

- A. Use rigid steel conduit only.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.7 WET OR DAMP LOCATIONS

- A. Use rigid steel or IMC conduits unless as shown on drawings
- B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.
- C. Use rigid steel or IMC conduit within 1.5 M (5 feet) of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers, unless as shown on drawings. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.
- D. Conduits run on roof shall be supported with integral galvanized lipped steel channel, attached to UV-inhibited polycarbonate or polypropylene blocks every 2.4 M (8 feet) with 9 mm (3/8-inch) galvanized threaded rods, square washer and locknut. Conduits shall be attached to steel channel with conduit clamps.

3.8 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.
- C. Provide a green equipment grounding conductor with flexible and liquid-tight flexible metal conduit.

3.9 EXPANSION JOINTS

- A. Conduits 75 mm (3 inch) 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 75 mm (3 inch) with junction boxes on both sides of the expansion joint. Connect flexible metal conduits to

junction boxes with sufficient slack to produce a 125 mm (5 inch) vertical drop midway between the ends of the flexible metal conduit. Flexible metal conduit shall have a green insulated copper bonding jumper installed. In lieu of this flexible metal conduit, expansion and deflection couplings as specified above are acceptable.

C. Install expansion and deflection couplings where shown.

3.10 CONDUIT SUPPORTS

- 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 an additional 90 kg (200 lbs). 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 6 mm (0.25-inch) bolt size and not less than 28 mm (1.125 inch) in embedment.
 - b. Power set fasteners not less than 6 mm (0.25-inch) diameter with depth of penetration not less than 75 mm (3 inch).
 - 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.

3.11 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 or where more than the equivalent of 4-90 degree bends are necessary.
- C. Locate pullboxes so that covers are accessible and easily removed. Coordinate locations with piping and ductwork where installed above ceilings.
- D. Remove only knockouts as required. Plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- E. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 600 mm (24 inch) center-to-center lateral spacing shall be maintained between boxes.
- F. 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.
- G. Minimum size of outlet boxes for ground fault circuit interrupter (GFCI) receptacles is 100 mm (4 inches) square x 55 mm (2.125 inches) deep, with device covers for the wall material and thickness involved.
- H. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."
- I. On all branch circuit junction box covers, identify the circuits with black marker.

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SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of underground ducts and raceways, and pull boxes to form a complete underground electrical raceway system.
- B. The terms "duct" and "conduit" are used interchangeably in this section.
- C. Work in this section is to provide two branch circuits underground to one light pole and to the propane tank power that will go under existing road. Also, one underground conduit for control wires.

1.2 RELATED WORK

- A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- 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 31 20 00, EARTHWORK Trenching, backfill, and compaction.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Coordinate layout and installation of ducts, manholes, and pull boxes with final arrangement of other utilities, site grading, and surface features.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.

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 Concrete Institute (ACI):
 BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE
 318-14/318M-14BUILDING CODE REQUIREMENTS FOR STRUCTURAL
 CONCRETE & COMMENTARY
 SP-66-04ACI DETAILING MANUAL
- C. American National Standards Institute (ANSI):
 77-14UNDERGROUND ENCLOSURE INTEGRITY
- D. American Society for Testing and Materials (ASTM):
 C478 REV A-15STANDARD SPECIFICATION FOR PRECAST REINFORCED
 CONCRETE MANHOLE SECTIONS
 C858-10UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES
 C990-09JOINTS FOR CONCRETE PIPE, MANHOLES AND PRECAST
 BOX SECTIONS USING PREFORMED FLEXIBLE JOINT
 SEALANTS.
- E. National Electrical Manufacturers Association (NEMA):
 TC 2-13ELECTRICAL POLYVINYL CHLORIDE (PVC) CONDUIT
 TC 3-15POLYVINYL CHLORIDE (PVC) FITTINGS FOR USE WITH
 RIGID PVC CONDUIT AND TUBING
 TC 6 & 8-13POLYVINYL CHLORIDE (PVC) PLASTIC UTILITIES DUCT
 FOR UNDERGROUND INSTALLATIONS
 TC 9-04FITTINGS FOR POLYVINYL CHLORIDE (PVC) PLASTIC
 UTILITIES DUCT FOR UNDERGROUND INSTALLATION
- F. National Fire Protection Association (NFPA):
 70-17NATIONAL ELECTRICAL CODE (NEC)
 70E-15NATIONAL ELECTRICAL SAFETY CODE
- G. Underwriters Laboratories, Inc. (UL):
 6-07ELECTRICAL RIGID METAL CONDUIT-STEEL
 467-13GROUNDING AND BONDING EQUIPMENT
 651-11SCHEDULE 40, 80, TYPE EB AND A RIGID PVC
 CONDUIT AND FITTINGS
 651A-11SCHEDULE 40 AND 80 HIGH DENSITY POLYETHYLENE
 (HDPE) CONDUIT

PART 2 - PRODUCTS

2.1 PRE-CAST CONCRETE MANHOLES AND HARDWARE - NOT USED.**2.2 PULLBOXES**

- A. General: Size as indicated on the drawings. Provide pull boxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pull box material. Covers shall have molded lettering, ELECTRIC or SIGNAL as applicable. Pull boxes shall comply with the requirements of ANSI 77 Tier 5 loading. Provide pulling irons, 22 mm (0.875 inch) diameter galvanized steel bar with exposed triangular-shaped opening.
- B. Fiberglass Pull boxes: Shall be sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
- C. Concrete Pull boxes: Shall be monolithically poured reinforced concrete.

2.3 DUCTS

- 1. Conduit Spacers: Prefabricated plastic.
- B. Ducts (direct burial):
 - 1. Plastic duct: Schedule 80 PVC
 - 2. Rigid metal conduit: UL 6 and NEMA RN1 galvanized rigid metal, half-lap wrapped with 10 mil PVC tape.

2.4 GROUNDING

- A. Ground Rods and Ground Wire: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

2.5 WARNING TAPE

- A. 4-mil polyethylene 75 mm (3 inches) wide detectable tape, red with black letters, imprinted with "CAUTION - BURIED ELECTRIC CABLE BELOW" or similar.

2.6 PULL ROPE FOR SPARE DUCTS

- A. Plastic with 890 N (200 lb) minimum tensile strength.

PART 3 - EXECUTION**3.1 MANHOLE AND PULLBOX INSTALLATION**

- A. Assembly and installation shall be per the requirements of the manufacturer.
 - 1. Install manholes and pull boxes level and plumb.

2. Units shall be installed on a 300 mm (12 inches) thick level bed of 90% compacted granular fill, well-graded from the 25 mm (1 inch) sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.
- B. Access: Ensure the top of frames and covers are flush with finished grade.
- C. Grounding in Manholes:
1. Ground Rods in Manholes: Drive a ground rod into the earth, through the floor sleeve, after the manhole is set in place. Fill the sleeve with sealant to make a watertight seal. Rods shall protrude approximately 100 mm (4 inches) above the manhole floor.
 2. Install a No. 3/0 AWG bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.
 3. Connect the ring grounding conductor to the ground rod by an exothermic welding process.
 4. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG bare copper jumper using an exothermic welding process.

3.2 TRENCHING

- A. Refer to Section 31 20 11 EARTH MOVING (SHORT FORM) for trenching, backfilling, and compaction.
- B. Before performing trenching work at existing facilities, a Ground Penetrating Radar Survey shall be carefully performed by a certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.
- C. Work with extreme care near existing ducts, conduits, and other utilities to avoid damaging them.
- D. Cut the trenches neatly and uniformly.
- E. Individual conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place using rigid metal conduit, or bored using plastic utilities duct or PVC conduit, as approved by the COR.

3.3 DUCT INSTALLATION

- A. General Requirements:

1. Ducts shall be in accordance with the NEC, as shown on the drawings, and as specified.
2. Join and terminate ducts with fittings recommended by the manufacturer.
3. Slope ducts to drain towards manholes and pull boxes, and away from building and equipment entrances. Pitch not less than 100 mm (4 inches) in 30 M (100 feet).
4. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) outside the building foundation. Tops of conduits below building slab shall be minimum 610 mm (24 inches) below bottom of slab.
5. Stub-ups and sweeps to equipment mounted on outdoor concrete slabs shall be galvanized rigid metal conduit half-lap wrapped with PVC tape, and shall extend a minimum of 1.5 M (5 feet) away from the edge of slab.
6. Install insulated grounding bushings on the conduit terminations.
7. Radius for sweeps shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter.
8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 75 mm (3 inches) above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 1.5 M (5 feet). Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during concrete pour. Tie wires shall not act as substitute for spacers.
9. Duct lines shall be installed no less than 300 mm (12 inches) from other utility systems, such as water, sewer, chilled water.
10. Clearances between individual ducts:
 - a. For similar services, not less than 75 mm (3 inches).
 - b. For power and signal services, not less than 150 mm (6 inches).
11. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.
12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to ensure maximum strength and rigidity of the duct bank.

13. Keep ducts clean of earth, sand, or gravel, and seal with tapered plugs upon completion of each portion of the work.
14. Spare Ducts: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
15. Duct Identification: Place continuous strip of warning tape approximately 300 mm (12 inches) above ducts before backfilling trenches. Warning tape shall be preprinted with proper identification.
16. Duct Sealing: Seal ducts, including spare ducts, at building entrances and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of foreign objects and material, moisture, and gases.
17. Use plastic ties to secure cables to insulators on cable arms. Use minimum two ties per cable per insulator.

B. Direct-Burial Ducts:

1. Install direct-burial ducts. Provide direct-burial ducts only for low-voltage power and lighting branch circuits.
2. Tops of ducts shall be:
 - a. Not less than 600 mm (24 inches) and not less than shown on the drawings, below finished grade.
 - b. Not less than 750 mm (30 inches) and not less than shown on the drawings, below roads and other paved surfaces.
 - c. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
3. Do not kink the ducts. Compaction shall not deform the ducts.

3.4 ACCEPTANCE CHECKS AND TESTS

A. Duct Testing and Cleaning:

1. Upon completion of the duct installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the duct, and to test for out-of-round conditions.
2. The mandrel shall be not less than 300 mm (12 inches) long and shall have a diameter not less than 13 mm (0.5 inch) less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The

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- diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
3. If testing reveals obstructions or out-of-round conditions, the Contractor shall replace affected section(s) of duct and retest to the satisfaction of the COR.
 4. Mandrel pulls shall be witnessed by the COR.

---END---

SECTION 26 05 73**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the overcurrent protective device coordination study, related calculations and analysis, indicated as the study in this section.
- B. A short-circuit and selective coordination study, and arc flash calculations and analysis shall be prepared for the electrical overcurrent devices to be installed under this project.
- C. The study shall present a well-coordinated time-current analysis of each overcurrent protective device from the individual device up to the utility source and the on-site generator sources.
- D. The study provides arc flash labels.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. The study shall be prepared by the equipment manufacturer, and performed by the equipment manufacturer's licensed electrical engineer.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Complete study as described in paragraph 1.6. Submittal of the study shall be well-coordinated with submittals of the shop drawings for equipment in related specification sections.
 - 2. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the Contractor that the overcurrent protective

devices have been set in accordance with the approved study.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. Institute of Electrical and Electronics Engineers (IEEE):
- 241-90RECOMMENDED PRACTICE ELECTRICAL SYSTEMS IN
COMMERCIAL BUILDINGS
- 242-03RECOMMENDED PRACTICE FOR PROTECTION AND
COORDINATION OF INDUSTRIAL AND COMMERCIAL POWER
SYSTEMS
- 399-97RECOMMENDED PRACTICE FOR INDUSTRIAL AND
COMMERCIAL POWER SYSTEMS ANALYSIS
- 1584-02PERFORMING ARC-FLASH HAZARDS CALCULATIONS
- 1584A-04PERFORMING ARC-FLASH HAZARDS CALCULATIONS -
AMENDMENT 1
- 1584B-11PERFORMING ARC-FLASH HAZARDS CALCULATIONS -
AMENDMENT 2
- C. National Fire Protection Association (NFPA):
- 70-17NATIONAL ELECTRICAL CODE (NEC)
- 70E-18STANDARD FOR ELECTRICAL SAFETY IN THE WORKPLACE
- 99-18HEALTH CARE FACILITIES CODE

1.6 STUDY REQUIREMENTS

- A. The study shall be in accordance with IEEE and NFPA standards.
- B. The study shall include one-line diagram, short-circuit and ground fault analysis, protective coordination plots for all overcurrent protective devices, and arc flash calculations and analysis.
- C. One Line Diagram:
1. Show all electrical equipment and wiring to be protected by the overcurrent devices.
 2. Show the following specific information:
 - a. Calculated fault impedance, X/R ratios, and short-circuit values

at each feeder and branch circuit bus.

- b. Relay, circuit breaker, and fuse ratings.
 - c. Generator kW/kVA and transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 - d. Voltage at each bus.
 - e. Identification of each bus, matching the identification on the drawings.
 - f. Conduit, conductor, and busway material, size, length, and X/R ratios.
- D. Short-Circuit Study:
1. The study shall be performed using computer software designed for this purpose. Pertinent data and the rationale employed in developing the calculations shall be described in the introductory remarks of the study.
 2. Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate applicable motor and/or generator contribution in determining the momentary and interrupting ratings of the overcurrent protective devices.
 3. Present the results of the short-circuit study in a table. Include the following:
 - a. Device identification.
 - b. Operating voltage.
 - c. Overcurrent protective device type and rating.
 - d. Calculated short-circuit current.
- E. Coordination Study:
1. Prepare the coordination curves to determine the required settings of overcurrent protective devices to demonstrate selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between devices, including the utility company upstream device if applicable. Plot the specific time-current characteristics of each overcurrent protective device in such a manner that all devices are clearly depicted.
 2. The following specific information shall also be shown on the coordination curves:
 - a. Device identification.

- b. Potential transformer and current transformer ratios.
 - c. Three-phase and single-phase ANSI damage points or curves for each cable, transformer, or generator.
 - d. Applicable circuit breaker or protective relay characteristic curves.
 - e. No-damage, melting, and clearing curves for fuses.
 - f. Transformer in-rush points.
3. Develop a table to summarize the settings selected for the overcurrent protective devices. Include the following in the table:
 - a. Device identification.
 - b. Protective relay or circuit breaker potential and current transformer ratios, sensor rating, and available and suggested pickup and delay settings for each available trip characteristic.
 - c. Fuse rating and type.
- F. Arc Flash Calculations and Analysis:
1. Arc flash warning labels shall comply with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS. Contractor to supply and install labels.
 2. Arc flash calculations shall be based on actual over-current protective device clearing time. Maximum clearing time shall be in accordance with IEEE 1584.
 3. Arc flash analysis shall be based on the lowest clearing time setting of the over-current protective device to minimize the incident energy level without compromising selective coordination.
 4. Arc flash boundary and available arc flash incident energy at the corresponding working distance shall be calculated for all electrical power distribution equipment specified in the project, and as shown on the drawings.
 5. Required arc-rated clothing and other PPE shall be selected and specified in accordance with NFPA 70E.

1.7 ANALYSIS

- A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose solutions to effectively protect the underrated equipment.

1.8 ADJUSTMENTS, SETTINGS, AND MODIFICATIONS

- A. Final field settings and minor modifications of the overcurrent

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protective devices shall be made to conform with the study, without
additional cost to the Government.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

---END---

SECTION 26 24 16**PANELBOARDS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of panelboards. No new panelboards are required for this project and this specification provides for modification on existing panelboards and breakers.

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 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.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.

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. International Code Council (ICC):

- IBC-15INTERNATIONAL BUILDING CODE
- C. National Electrical Manufacturers Association (NEMA):
 PB 1-11PANELBOARDS
 250-14ENCLOSURES FOR ELECTRICAL EQUIPMENT (1,000V
 MAXIMUM)
- D. National Fire Protection Association (NFPA):
 70-17NATIONAL ELECTRICAL CODE (NEC)
 70E-18STANDARD FOR ELECTRICAL SAFETY IN THE WORKPLACE
- E. Underwriters Laboratories, Inc. (UL):
 50-15ENCLOSURES FOR ELECTRICAL EQUIPMENT
 67-09PANELBOARDS
 489-16MOLDED CASE CIRCUIT BREAKERS AND CIRCUIT
 BREAKER ENCLOSURES

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

2.2 MOLDED CASE CIRCUIT BREAKERS

- A. Circuit breakers shall be per UL, NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt-on type.
- C. Circuit breakers shall have minimum interrupting rating as required to withstand the available fault current, but not less than:
1. 120/208 V Panelboard: 10,000 A symmetrical.
 2. 120/240 V Panelboard: 10,000 A symmetrical.
 3. 277/480 V Panelboard: 14,000 A symmetrical.
- D. Circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for less than 400 A frame. Circuit breakers with 400 A frames and above shall have magnetic trip, adjustable from 5x to 10x. Breaker magnetic trip setting shall be set to maximum, unless otherwise noted.
- E. Circuit breaker features shall be as follows:
1. A rugged, integral housing of molded insulating material.
 2. Silver alloy contacts.
 3. Arc quenchers and phase barriers for each pole.
 4. Quick-make, quick-break, operating mechanisms.
 5. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
 6. Electrically and mechanically trip free.

7. An operating handle which indicates closed, tripped, and open positions.
8. An overload on one pole of a multi-pole breaker shall automatically cause all the poles of the breaker to open.
9. Ground fault current interrupting breakers, shunt trip breakers, lighting control breakers (including accessories to switch line currents), or other accessory devices or functions shall be provided where shown on the drawings.
10. For circuit breakers being added to existing panelboards, coordinate the breaker manufacturer, type and AIC rating with existing panelboards. Provide new typewritten panel directory for any new, removed or re-arranged circuit breakers.

2.3 SURGE PROTECTIVE DEVICES - NOT USED.

A.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's instructions, the NEC, as shown on the drawings, and as specified.
- B. Install a printed schedule of circuits in each panelboard after approval by the COR. Schedules shall reflect final load descriptions, room numbers, and room names connected to each circuit breaker. Schedules shall be printed on the panelboard directory cards and be installed in the appropriate panelboards
- C. Provide blank cover for each unused circuit breaker mounting space.
- D. Panelboard enclosures shall not be used for conductors feeding through, spliced, or tapping off to other enclosures or devices.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify appropriate anchorage and required area clearances.
 - d. Verify that circuit breaker sizes and types correspond to approved shop drawings.

- e. To verify tightness of accessible bolted electrical connections, use the calibrated torque-wrench method or perform thermographic survey after energization.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall demonstrate that the panelboards are in good operating condition and properly performing the intended function.

---END---

SECTION 26 24 19
MOTOR CONTROL CENTERS

PART 1 - GENERAL**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, connection, and testing modification of the existing motor control centers. For this project there will be no new MCCs but will require work in an existing MCC>

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 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 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
Short circuit and coordination study, and requirements for a coordinated electrical system.
- E. Section 26 29 11, MOTOR CONTROLLERS: Control and protection of motors.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 2. Manuals: Not required.

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. International Code Council (ICC):
IBC-15INTERNATIONAL BUILDING CODE
- C. National Electrical Manufacturers Association (NEMA):
ICS 1-00(R2015)INDUSTRIAL CONTROL AND SYSTEMS: GENERAL REQUIREMENTS
ICS 2-00(R2005)INDUSTRIAL CONTROL AND SYSTEMS: CONTROLLERS, CONTACTORS AND OVERHEAD RELAYS RATED 600 VOLTS
ICS 6-93(R2016)INDUSTRIAL CONTROL AND SYSTEMS: ENCLOSURES
FU 1-12LOW-VOLTAGE CARTRIDGE FUSES
250-14ENCLOSURES FOR ELECTRICAL EQUIPMENT (1000 VOLTS MAXIMUM)
- D. National Fire Protection Association (NFPA):
70-17NATIONAL ELECTRICAL CODE (NEC)
- E. Underwriters Laboratories, Inc. (UL):
845-05MOTOR CONTROL CENTERS

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Motor control centers shall comply with NFPA, NEMA, UL, and as shown on drawings.
- B. Enclosure shall be NEMA-type rated 1, 3R, or 12 as indicated on drawings or as required per the installed environment.

2.2 MOTOR CONTROLLERS

- A. Product of the same manufacturer as the motor control centers.
- B. Shall conform to the applicable requirements in Section 26 29 11, MOTOR CONTROLLERS.
- C. Plug-in, draw-out type up through NEMA size 4. NEMA size 5 and above require bolted connections.
- D. Doors for each space shall be interlocked to prevent their opening unless disconnect is open. A "defeater" mechanism shall be incorporated for inspection by qualified personnel.

2.3 FEEDER UNITS

- A. Circuit breaker: shall conform to the applicable portions of Section 26 24 16, PANELBOARDS.
- B. Fusible Switches: shall conform to the applicable portions of Section 26 29 21, ENCLOSED SWITCHES AND CIRCUIT BREAKERS.

PART 3 - EXECUTION

3.1 INSTALLATION

01-01-18

---END---

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of wiring devices.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and boxes.
- E. Section 26 51 00, INTERIOR LIGHTING: Fluorescent ballasts and LED drivers for use with manual dimming controls.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
- B. Shop Drawings:
1. Submit sufficient information to demonstrate compliance with drawings and specifications.
 2. Include electrical ratings, dimensions, mounting details, construction materials, grade, and termination information.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions,

supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

- B. National Electrical Manufacturers Association (NEMA):
 - WD 1-99(R2015).....GENERAL COLOR REQUIREMENTS FOR WIRING DEVICES
 - WD 6-16WIRING DEVICES - DIMENSIONAL SPECIFICATIONS
- C. National Fire Protection Association (NFPA):
 - 70-17.....NATIONAL ELECTRICAL CODE (NEC)
 - 99-18.....HEALTH CARE FACILITIES
- D. Underwriter's Laboratories, Inc. (UL):
 - 5-16.....SURFACE METAL RACEWAYS AND FITTINGS
 - 20-10.....GENERAL-USE SNAP SWITCHES
 - 231-16.....POWER OUTLETS
 - 467-13.....GROUNDING AND BONDING EQUIPMENT
 - 498-17.....ATTACHMENT PLUGS AND RECEPTACLES
 - 943-16.....GROUND-FAULT CIRCUIT-INTERRUPTERS
 - 1449-14.....SURGE PROTECTIVE DEVICES
 - 1472-15.....SOLID STATE DIMMING CONTROLS

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. General: All receptacles shall comply with NEMA, NFPA, UL, and as shown on the drawings.
 - 1. Mounting straps shall be nickel plated brass, brass, nickel plated steel or galvanize steel with break-off plaster ears, and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
 - 2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four minimum) and side wiring from four captively held binding screws.
 - 3. Duplex Receptacles on Emergency Circuit:
 - a. In rooms without emergency powered general lighting, the emergency receptacles shall be of the self-illuminated type.
 - 4. Ground Fault Current Interrupter (GFCI) Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box, with end-of-life indication and provisions to isolate the face due to improper wiring. GFCI receptacles shall be

self-test receptacles in accordance with UL 943.

- a. Ground fault interrupter shall consist of a differential current transformer, self-test, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of 4-6 milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or - 1 milliampere) on the load side of the device. Device shall have a minimum nominal tripping time of 0.025 second.
 - b. Self-test function shall be automatically initiated within 5 seconds after power is activated to the receptacles. Self-test function shall be periodically and automatically performed every 3 hours or less.
 - c. End-of-life indicator light shall be a persistent flashing or blinking light to indicate that the GFCI receptacle is no longer in service.
- B. Duplex Receptacles - Non-hospital Grade: shall be the same as duplex receptacles - hospital grade in accordance with sections 2.1A and 2.1B of this specification, except for the hospital grade listing.
- 1. Bodies shall match existing and shall be nylon.
- C. Receptacles - 20, 30, and 50 ampere, 250 Volts: Shall be complete with appropriate cord grip plug.
- D. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate and cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.
- E. Cable Reel Receptacles: -(NOT USED)

2.2 TOGGLE SWITCHES

- A. Toggle switches shall be totally enclosed tumbler type with nylon bodies. Handles shall match existing in color unless otherwise specified or shown on the drawings.
 - 1. Switches installed in hazardous areas shall be explosion-proof type in accordance with the NEC and as shown on the drawings.

2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self-grounding mounting strap with break-off plaster ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.

B. Switches shall be rated 20 amperes at 120-277 Volts AC.

2.3 Manual Dimming Control - (NOT USED)

2.4 WALL PLATES

- A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.
- B. Color shall match existing unless otherwise specified.
- C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- D. In areas requiring tamperproof wiring devices, wall plates shall be type 302 stainless steel, and shall have tamperproof screws and beveled edges.
- E. Duplex Receptacles on Emergency Circuit: Wall plates shall be type 302 stainless steel, with the word "EMERGENCY" engraved in 6 mm (1/4 inch) red letters.

2.5 SURFACE MULTIPLE-OUTLET ASSEMBLIES - (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC and as shown as on the drawings.
- B. Install wiring devices after wall construction and painting is complete.
- C. The ground terminal of each wiring device shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the branch circuit equipment grounding conductor.
- D. Outlet boxes for toggle switches and manual dimming controls shall be mounted on the strike side of doors.
- E. Provide barriers in multi-gang outlet boxes to comply with the NEC.
- F. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special

attention to installations in cabinet work, and in connection with laboratory equipment.

- G. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades.
- H. Install wall switches 1.2 M (48 inches) above floor, with the toggle OFF position down.
- I. Install wall dimmers 1.2 M (48 inches) above floor.
- J. Install receptacles 450 mm (18 inches) above floor, and 152 mm (6 inches) above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.
- K. Install horizontally mounted receptacles with the ground pin to the right.
- L. When required or recommended by the manufacturer, use a torque screwdriver. Tighten unused terminal screws.
- M. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform manufacturer's required field checks in accordance with the manufacturer's recommendations, and the latest NFPA 99. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Inspect physical and electrical conditions.
 - b. Vacuum-clean surface metal raceway interior. Clean metal raceway exterior.
 - c. Test wiring devices for damaged conductors, high circuit resistance, poor connections, inadequate fault current path, defective devices, or similar problems using a portable receptacle tester. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.
 - d. Test GFCI receptacles.
 - 2. Receptacle testing in the Patient Care Spaces, such as retention force of the grounding blade of each receptacle, shall comply with the

latest NFPA 99.

01-01-18

---END---

SECTION 26 29 11
MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of motor controllers, including all low-voltage motor controllers and manual motor controllers, indicated as motor controllers in this section, and low-voltage variable speed motor controllers.
- B. Motor controllers, whether furnished with the equipment specified in other sections, shall meet this specification and all related specifications.

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 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.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Include electrical ratings, dimensions, weights, mounting details, materials, overcurrent protection devices, overload

relays, sizes of enclosures, wiring diagrams, starting characteristics, interlocking, and accessories.

2. Certifications: Two weeks prior to final inspection, submit the following.

- a. Certification by the manufacturer that the motor controllers conform to the requirements of the drawings and specifications.
- b. Certification by the Contractor that the motor controllers have been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

- B. Institute of Electrical and Electronic Engineers (IEEE):
 519-14RECOMMENDED PRACTICES AND REQUIREMENTS FOR HARMONIC CONTROL IN ELECTRICAL POWER SYSTEMS
 C37.90.1-12STANDARD SURGE WITHSTAND CAPABILITY (SWC) TESTS FOR RELAYS AND RELAY SYSTEMS ASSOCIATED WITH ELECTRIC POWER APPARATUS

C. International Code Council (ICC):
 IBC-15INTERNATIONAL BUILDING CODE

- D. National Electrical Manufacturers Association (NEMA):
 ICS 1-00 (R2015)INDUSTRIAL CONTROL AND SYSTEMS: GENERAL REQUIREMENTS
 ICS 1.1-84 (R2015)SAFETY GUIDELINES FOR THE APPLICATION, INSTALLATION AND MAINTENANCE OF SOLID STATE CONTROL
 ICS 2-00 (R2005)INDUSTRIAL CONTROL AND SYSTEMS CONTROLLERS, CONTACTORS, AND OVERLOAD RELAYS RATED 600 VOLTS
 ICS 4-15INDUSTRIAL CONTROL AND SYSTEMS: TERMINAL BLOCKS
 ICS 6-93 (R2016)INDUSTRIAL CONTROL AND SYSTEMS: ENCLOSURES
 ICS 7-14INDUSTRIAL CONTROL AND SYSTEMS: ADJUSTABLE-SPEED DRIVES
 ICS 7.1-14SAFETY STANDARDS FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION, AND OPERATION OF ADJUSTABLE-SPEED DRIVE SYSTEMS

E. National Fire Protection Association (NFPA):
 70-17NATIONAL ELECTRICAL CODE (NEC)

F. Underwriters Laboratories Inc. (UL):

508A-13INDUSTRIAL CONTROL PANELS
508C-16POWER CONVERSION EQUIPMENT
1449-14SURGE PROTECTIVE DEVICES

PART 2 - PRODUCTS

2.1 MOTOR CONTROLLERS

- A. Motor controllers shall comply with IEEE, NEMA, NFPA, UL, and as shown on the drawings.
- B. Motor controllers shall be separately enclosed, unless part of another assembly. For installation in motor control centers, provide plug-in, draw-out type motor controllers up through NEMA size 4. NEMA size 5 and above require bolted connections.
- C. Motor controllers shall be combination type, with magnetic controller per Paragraph 2.3 below and with circuit breaker or fused switch disconnecting means, with external operating handle with lock-open padlocking positions and ON-OFF position indicator per specific boiler equipment.

1. Circuit Breakers:

- a. Bolt-on thermal-magnetic type with a minimum interrupting rating as indicated on the drawings.
- b. Equipped with automatic, trip free, non-adjustable, inverse-time, and instantaneous magnetic trips for less than 400A. The magnetic trip shall be adjustable from 5x to 10x for breakers 400A and greater.
- c. Additional features shall be as follows:
 - 1) A rugged, integral housing of molded insulating material.
 - 2) Silver alloy contacts.
 - 3) Arc quenchers and phase barriers for each pole.
 - 4) Quick-make, quick-break, operating mechanisms.
 - 5) A trip element for each pole, a common trip bar for all poles, and one operator for all poles.

2. Fused Switches:

- a. Quick-make, quick-break type.
- b. Minimum duty rating shall be NEMA classification General Duty (GD) for 240 Volts and NEMA classification Heavy Duty (HD) for 480 Volts.
- c. Horsepower rated, and shall have the following features:

- 1) Copper blades, visible in the OFF position.
- 2) An arc chute for each pole.
- 3) Fuse holders for the sizes and types of fuses specified or as shown on the drawings.

3. Motor Circuit Protectors: -(NOT USED)

D. Enclosures:

1. Enclosures shall be NEMA-type rated 1, 3R, or 12 as indicated on the drawings or as required per the installed environment.
2. Enclosure doors shall be interlocked to prevent opening unless the disconnecting means is open. A "defeater" mechanism shall allow for inspection by qualified personnel with the disconnect means closed. Provide padlocking provisions.
3. All metal surfaces shall be thoroughly cleaned, phosphatized, and factory primed prior to applying light gray baked enamel finish.

E. Motor control circuits:

1. Shall operate at not more than 120 Volts.
2. Shall be grounded, except where the equipment manufacturer recommends that the control circuits be isolated.
3. For each motor operating over 120 Volts, incorporate a separate, heavy duty, control transformer within each motor controller enclosure.
4. Incorporate primary and secondary overcurrent protection for the control power transformers.

F. Overload relays: -(NOT USED)

G. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular controller. H-O-A switch shall be operable without opening enclosure door. H-O-A switch is not required for manual motor controllers. -(NOT USED)

H. Incorporate into each control circuit a 120 Volt, electronic time-delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time-delay relay is not required where H-O-A switch is not required. -(NOT USED)

I. Unless noted otherwise, equip each motor controller with not less than two normally open (N.O.) and two normally closed (N.C.) auxiliary contacts. -(NOT USED)

J. Provide green (RUN) and red (STOP) pilot lights. -(NOT USED)

- K. Motor controllers incorporated within equipment assemblies shall also be designed for the specific requirements of the assemblies. –(NOT USED)
- L. Additional requirements for specific motor controllers, as indicated in other specification sections, shall also apply. –(NOT USED)

2.2 MANUAL MOTOR CONTROLLERS – (NOT USED)

2.3 MAGNETIC MOTOR CONTROLLERS

- A. A. Shall be in accordance with applicable requirements of 2.1 above.
- B. B. Controllers shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum NEMA size 0.
- C. C. Where combination motor controllers are used, combine controller with protective or disconnect device in a common enclosure.
- D. D. Provide phase loss protection for each controller, with contacts to de-energize the controller upon loss of any phase.
- E. E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced-voltage or variable speed controllers as shown on the drawings. Equip controllers with 120 VAC coils and individual control transformer unless otherwise noted.

2.4 REDUCED VOLTAGE MOTOR CONTROLLERS – (NOT USED)

2.5 MEDIUM-VOLTAGE MOTOR CONTROLLERS – (NOT USED)

2.6 LOW-VOLTAGE VARIABLE SPEED MOTOR CONTROLLERS (VSMC)

- A. VSMC shall be in accordance with applicable portions of 2.1 above. VFD should be supplied as part of mechanical equipment and matched to the equipment.
- B. VSMC shall be electronic, with adjustable frequency and voltage, three phase output, capable of driving standard NEMA B three-phase induction motors at full rated speed. The control technique shall be pulse width modulation (PWM), where the VSMC utilizes a full wave bridge design incorporating diode rectifier circuitry. Silicon controlled rectifiers or other control techniques are not acceptable.
- C. VSMC shall be suitable for variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.

- D. VSMC shall be capable of operating within voltage parameters of plus 10 to minus 15 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- E. Minimum efficiency shall be 95 percent at 100 percent speed and 85 percent at 50 percent speed.
- F. The displacement power factor of the VSMC shall not be less than 95 percent under any speed or load condition.
- G. VSMC current and voltage harmonic distortion shall not exceed the values allowed by IEEE 519.
- H. Operating and Design Conditions:
 - 1. Elevation: feet Above Mean Sea Level (AMSL)
 - 2. Temperatures: Maximum +90°F Minimum -10°F
 - 3. Relative Humidity: 95%
 - 4. VSMC Location: Air-conditioned space
- I. VSMC shall have the following features:
 - 1. Isolated power for control circuits.
 - 2. Manually resettable overload protection for each phase.
 - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
 - 4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 2000 seconds. Set timers to the equipment manufacturer's recommended time in the above range.
 - 5. Control input circuitry that will accept 4 to 20 mA current or 0-10 VDC voltage control signals from an external source.
 - 6. Automatic frequency adjustment from 1 Hz to 300 Hz.
 - 7. Circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The VSMC shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The VSMC shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
 - a. Incorrect phase sequence.
 - b. Single phasing.
 - c. Overvoltage in excess of 10 percent.
 - d. Undervoltage in excess of 15 percent.

- e. Running overcurrent above 110 percent (VSMC shall not automatically reset for this condition.)
 - f. Instantaneous overcurrent above 150 percent (VSMC shall not automatically reset for this condition).
 - g. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Automatic Reset/Restart: Attempt three restarts after VSMC fault or on return of power after an interruption and before shutting down for manual reset or fault correction, with adjustable delay time between restart attempts.
9. Bidirectional Autospeed Search: Capable of starting VSMC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to VSMC, motor, or load.
- J. VSMC shall include an input circuit breaker which will disconnect all input power, interlocked with the door so that the door cannot be opened with the circuit breaker in the closed position.
- K. VSMC shall include a 5% line reactor and a RFI/EMI filter.
- L. Surge Suppression: Provide three-phase protection against damage from supply voltage surges in accordance with UL 1449.
- M. VSMC shall include front-accessible operator station, with sealed keypad and digital display, which allows complete programming, operating, monitoring, and diagnostic capabilities.
- 1. Typical control functions shall include but not be limited to:
 - a. HAND-OFF-AUTOMATIC-RESET, with manual speed control in HAND mode.
 - b. NORMAL-BYPASS.
 - c. NORMAL-TEST, which allows testing and adjusting of the VSMC while in bypass mode.
 - 2. Typical monitoring functions shall include but not be limited to:
 - a. Output frequency (Hz).
 - b. Motor speed and status (run, stop, fault).
 - c. Output voltage and current.
 - 3. Typical fault and alarm functions shall include but not be limited to:
 - a. Loss of input signal, under- and over-voltage, inverter

overcurrent, motor overload, critical frequency rejection with selectable and adjustable deadbands, instantaneous line-to-line and line-to-ground overcurrent, loss-of-phase, reverse-phase, and short circuit.

- b. System protection indicators indicating that the system has shutdown and will not automatically restart.
- N. VSMC shall include two N.O. and two N.C. dry contacts rated 120 Volts, 10 amperes, 60 Hz.
- O. Hardware, software, network interfaces, gateways, and programming to control and monitor the VSMC by control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- P. Network communications ports: As required for connectivity to control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- Q. Communications protocols: As required for communications with control systems specified in other specification sections, including but not limited to Divisions 22 and 23.
- R. Bypass controller: Provide contactor-style bypass, arranged to bypass the inverter.
 - 1. Inverter Output Contactor and Bypass Contactor: Load-break NEMA-rated contactor.
 - 2. Motor overload relays.
 - 3. HAND-OFF-AUTOMATIC bypass control.
- S. Bypass operation: Transfers motor between inverter output and bypass circuit, manually, automatically, or both. VSMC shall be capable of stable operation (starting, stopping, and running), and control by fire alarm and detection systems, with motor completely disconnected from the inverter output. Transfer between inverter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- T. Inverter Isolating Switch: Provide non-load-break switch arranged to isolate inverter and permit safe troubleshooting and testing of the inverter, both energized and de-energized, while motor is operating in bypass mode. Include padlockable, door-mounted handle mechanism.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor controllers in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and electronic overload relay pickup and trip ranges.
- C. Program variable speed motor controllers per the manufacturer's instructions and in coordination with other trades so that a complete and functional system is delivered.
- D. Adjust trip settings of circuit breakers and motor circuit protectors with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficiency motors if required). Where these maximum settings do not allow starting of a motor, notify COR before increasing settings.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify appropriate anchorage, required area clearances, and correct alignment.
 - d. Verify that circuit breaker, motor circuit protector, and fuse sizes and types correspond to approved shop drawings.
 - e. Verify overload relay ratings are correct.
 - f. Vacuum-clean enclosure interior. Clean enclosure exterior.
 - g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - h. Test all control and safety features of the motor controllers.
 - i. For low-voltage variable speed motor controllers, final programming and connections shall be by a factory-trained

technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor controllers are in good operating condition and properly performing the intended functions.

3.4 SPARE PARTS

- A. Two weeks prior to the final inspection, provide one complete set of spare fuses for each motor controller.

3.5 INSTRUCTION

- A. Furnish the services of a factory-trained technician for two 4-hour training periods for instructing personnel in the maintenance and operation of the motor controllers, on the dates requested by the COR.

---END---

SECTION 26 29 21**ENCLOSED SWITCHES AND CIRCUIT BREAKERS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation, and connection of fused and unfused disconnect switches (indicated as switches in this section), and separately enclosed circuit breakers for use in electrical systems rated 600 V and below.

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 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- E. Section 26 24 16, PANELBOARDS: Molded-case circuit breakers.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.

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. International Code Council (ICC):
IBC-15INTERNATIONAL BUILDING CODE
- C. National Electrical Manufacturers Association (NEMA):
FU L-12LOW VOLTAGE CARTRIDGE FUSES
KS L-13HEAVY DUTY ENCLOSED AND DEAD-FRONT SWITCHES
(600 VOLTS MAXIMUM)
- D. National Fire Protection Association (NFPA):
70-17NATIONAL ELECTRICAL CODE (NEC)
- E. Underwriters Laboratories, Inc. (UL):
98-16ENCLOSED AND DEAD-FRONT SWITCHES
248 1-11LOW VOLTAGE FUSES
489-13MOLDED CASE CIRCUIT BREAKERS AND CIRCUIT
BREAKER ENCLOSURES

PART 2 - PRODUCTS

2.1 FUSED SWITCHES RATED 600 AMPERES AND LESS

- A. Switches shall be in accordance with NEMA, NEC, UL, as specified, and as shown on the drawings.
- B. Shall be NEMA classified General Duty (GD) for 240 V switches, and NEMA classified Heavy Duty (HD) for 480 V switches.
- C. Shall be horsepower (HP) rated.
- D. Shall have the following features:
 - 1. Switch mechanism shall be the quick-make, quick-break type.
 - 2. Copper blades, visible in the open position.
 - 3. An arc chute for each pole.
 - 4. External operating handle shall indicate open and closed positions and have lock-open padlocking provisions.
 - 5. Mechanical interlock shall permit opening of the door only when the switch is in the open position, defeatable to permit inspection.
 - 6. Fuse holders for the sizes and types of fuses specified.
 - 7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
 - 8. Ground lugs for each ground conductor.
 - 9. Enclosures:
 - a. Shall be the NEMA types shown on the drawings.
 - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions.
 - c. Shall be finished with manufacturer's standard gray baked enamel

paint over pretreated steel.

2.2 UNFUSED SWITCHES RATED 600 AMPERES AND LESS

A. Shall be the same as fused switches, but without provisions for fuses.

2.3 MOTOR RATED TOGGLE SWITCHES

- A. Type 1, general purpose for single-phase motors rated up to 1 horsepower.
- B. Quick-make, quick-break toggle switch with external reset button and thermal overload protection matched to nameplate full-load current of actual protected motor.

2.4 CARTRIDGE FUSES

- A. Shall be in accordance with NEMA FU 1.
- B. Feeders: Class RK5, fast acting or Class J, fast acting
- C. Motor Branch Circuits: Class RK5, time delay.
- D. Other Branch Circuits: Class J, fast acting
- E. Control Circuits: Class CC,

2.5 SEPARATELY-ENCLOSED CIRCUIT BREAKERS - (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. Fused switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuses.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations. In addition, include the following:
 - 1. Visual Inspection and Tests:
 - a. Compare equipment nameplate data with specifications and approved shop drawings.
 - b. Inspect physical, electrical, and mechanical condition.
 - c. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method.
 - d. Vacuum-clean enclosure interior. Clean enclosure exterior.

3.3 SPARE PARTS

- A. Two weeks prior to the final inspection, furnish one complete set of

01-01-17

spare fuses for each fused disconnect switch installed on the project.

Deliver the spare fuses to the COR.

---END---

SECTION 26 41 00
FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing and installation of a complete UL master labeled lightning protection system. For this project connect lightning protection from new smokestacks to existing system and recertify.

1.2 RELATED WORK

- A. Section 07 60 00, FLASHING AND SHEET METAL: Penetrations through the roof.
- 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 to ground for possible ground faults.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - b. Show locations of air terminals, connections to required metal surfaces, down conductors, and grounding means.
 - c. Show the mounting hardware and materials used to attach air terminals and conductors to the structure.
 2. Certifications: Two weeks prior to final inspection, submit the following.
 - a. Certification by the manufacturer that the lightning protection system conforms to the requirements of the drawings and specifications.

- b. Certification by the Contractor that the lightning protection system has been properly installed and inspected.
- c. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Fire Protection Association (NFPA):
 - 70-17National Electrical Code (NEC)
 - 780-17Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL):
 - 96-16Lightning Protection Components
 - 96A-16Installation Requirements for Lightning Protection Systems
 - 467-13Standard for Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Lightning protection components shall conform to NFPA 780 and UL 96, for use on Class I structures. Aluminum materials are not allowed.
 - 1. Class I conductors: Copper.
 - 2. Class I air terminals: Solid copper, 460 mm (18 inches) long, not less than 9.5 mm (3/8 inch) diameter, with sharp bare copper points.
 - 9. Anchors and fasteners: Bronze bolt and clamp type shall be used for all applications except for membrane roof. Adhesive type are allowed only for attachment to membrane roof materials, using adhesive that is compatible with the membrane material.
 - 10. Connectors: Bronze clamp-type connectors shall be used for roof conductor splices, and the connection of the roof conductor to air terminals and bonding plates. Crimp-type connectors are not allowed.
 - 11. Exothermic welds: Exothermic welds shall be used for splicing the roof conductor to the down conductors, splices of the down

conductors, and for connection of the down conductors to ground rods, ground plates, and the ground ring.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B.
- J. Connect roof conductors to all metallic projections and equipment above the roof as indicated on the drawings.
- K. Connect exterior metal surfaces, located within 900 mm (3 feet) of the conductors, to the conductors to prevent flashovers.
- L. Maintain horizontal or downward coursing of main conductor and ensure that all bends have at least a 200 mm (8 inches) radius and do not exceed 90 degrees.
- M. Conductors shall be rigidly fastened every 900 mm (3 feet) along the roof and down to the building to ground.
- N. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure.
- O. Install air terminal bases, cable holders and other roof-system supporting means without piercing membrane or metal roofs.
- V. Where the drawings show the new lightning protection system connected to an existing lightning protection system with or without a UL master label, the new portion of the lightning protection system requires UL inspection and a Letter of Findings.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- B. A UL representative shall inspect the lightning protection system. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the COR.

---END---

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies the furnishing, installation, and connection of the interior lighting systems. The terms "lighting fixture," "fixture," and "luminaire" are used interchangeably.

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 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS:
Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
 - b. Material and construction details include information on housing and optics system.

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):
 - C635/C635M REV A-13MANUFACTURE, PERFORMANCE, AND TESTING OF METAL SUSPENSION SYSTEMS FOR ACOUSTICAL TILE AND LAY-IN PANEL CEILINGS
- C. Environmental Protection Agency (EPA):
 - 40 CFR 261IDENTIFICATION AND LISTING OF HAZARDOUS WASTE
- D. Federal Communications Commission (FCC):
 - CFR TITLE 47, PART 15 ..RADIO FREQUENCY DEVICES
 - CFR TITLE 47, PART 18 ..INDUSTRIAL, SCIENTIFIC, AND MEDICAL EQUIPMENT
- E. Illuminating Engineering Society of North America (IESNA):
 - LM-79-08ELECTRICAL AND PHOTOMETRIC MEASUREMENTS OF SOLID-STATE LIGHTING PRODUCTS
 - LM-80-15MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES
 - LM-82-12CHARACTERIZATION OF LED LIGHT ENGINES AND LED LAMPS FOR ELECTRICAL AND PHOTOMETRIC PROPERTIES AS A FUNCTION OF TEMPERATURE
- F. Institute of Electrical and Electronic Engineers (IEEE):
 - C62.41-91(R1995)SURGE VOLTAGES IN LOW VOLTAGE AC POWER CIRCUITS
- G. International Code Council (ICC):
 - IBC-15INTERNATIONAL BUILDING CODE
- H. National Electrical Manufacturer's Association (NEMA):
 - C78.376-14CHROMATICITY OF FLUORESCENT LAMPS
 - C82.1-04(R2015)LAMP BALLASTS - LINE FREQUENCY FLUORESCENT LAMP BALLASTS
 - C82.2-02(R2016)METHOD OF MEASUREMENT OF FLUORESCENT LAMP BALLASTS
 - C82.4-17LAMP BALLASTS - BALLASTS FOR HIGH-INTENSITY DISCHARGE AND LOW-PRESSURE SODIUM (LPS) LAMPS (MULTIPLE-SUPPLY TYPE)
 - C82.11-17LAMP BALLASTS - HIGH FREQUENCY FLUORESCENT LAMP BALLASTS
 - LL 9-11DIMMING OF T8 FLUORESCENT LIGHTING SYSTEMS
 - SSL 1-16ELECTRONIC DRIVERS FOR LED DEVICES, ARRAYS, OR SYSTEMS
- I. National Fire Protection Association (NFPA):
 - 70-17NATIONAL ELECTRICAL CODE (NEC)
 - 101-18LIFE SAFETY CODE
- J. Underwriters Laboratories, Inc. (UL):

496-17	.....LAMP HOLDERS
542-05	.....FLUORESCENT LAMP STARTERS
844-12	.....LUMINAIRES FOR USE IN HAZARDOUS (CLASSIFIED) LOCATIONS
924-16	.....EMERGENCY LIGHTING AND POWER EQUIPMENT
935-01	.....FLUORESCENT-LAMP BALLASTS
1029-94	.....HIGH-INTENSITY-DISCHARGE LAMP BALLASTS
1029A-06	.....IGNITORS AND RELATED AUXILIARIES FOR HID LAMP BALLASTS
1598-08	.....LUMINAIRES
1574-04	.....TRACK LIGHTING SYSTEMS
2108-15	.....LOW-VOLTAGE LIGHTING SYSTEMS
8750-15	.....LIGHT EMITTING DIODE (LED) LIGHT SOURCES FOR USE IN LIGHTING PRODUCTS

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

- A. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified.
- B. Sheet Metal:
 - 1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
 - 2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
 - 3. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
 - 4. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
- C. Lamp Sockets: -(NOT USED)
- D. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings. -(NOT USED)
- E. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance. -(NOT USED)

F. Metal Finishes:

1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt, and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping, or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
2. Interior light reflecting finishes shall be white with not less than 85 percent reflectance, except where otherwise shown on the drawing.

G. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

H. Light Transmitting Components for Fluorescent Fixtures: -(NOT USED)

I. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.

2.2 BALLASTS - (NOT USED)**2.3 FLUORESCENT EMERGENCY BALLAST - (NOT USED)****2.4 EMERGENCY LIGHTING UNIT - NOT USED****2.5 LAMPS - (NOT USED)****2.6 RADIO-INTERFERENCE-FREE FLUORESCENT FIXTURES -(NOT USED)****2.7 WALL MOUNTED FLOURESCENT BED LIGHT FIXTURES -(NOT USED)****2.8 X-RAY FILM ILLUMINATORS -(NOT USED)****2.9 LED EXIT LIGHT FIXTURES - NOT USED****2.10 LED LIGHT FIXTURES**

A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)

- c. Input Voltage: 120 - 277V ($\pm 10\%$) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: ≥ 0.95 .
 - f. Total Harmonic Distortion: $\leq 20\%$.
 - g. Comply with FCC 47 CFR Part 15.
4. LED modules shall include the following features unless otherwise indicated:
- a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 3000° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, manufacturer's instructions, and as shown on the drawings or specified.
- B. Align, mount, and level the lighting fixtures uniformly.
- C. Wall-mounted fixtures shall be attached to the studs in the walls, or to a 20-gauge metal backing plate that is attached to the studs in the walls. Lighting fixtures shall not be attached directly to gypsum board.
- D. Lighting Fixture Supports:
 - 1. Shall provide support for all the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
 - 2. Shall maintain the fixture positions after cleaning and relamping.
 - 3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
 - 4. Hardware for recessed fluorescent fixtures: **-(NOT USED)**
 - .
 - 5. Surface mounted lighting fixtures:
 - a. Fixtures shall be bolted against the ceiling independent of the outlet box at four points spaced near the corners of each unit. The bolts (or stud-clips) shall be minimum 6 mm (1/4 inch) bolt,

secured to main ceiling runners and/or secured to cross runners. Non-turning studs may be attached to the main ceiling runners and cross runners with special non-friction clip devices designed for the purpose, provided they bolt through the runner, or are also secured to the building structure by 12 gauge safety hangers. Studs or bolts securing fixtures weighing in excess of 25 kg (56 pounds) shall be supported directly from the building structure.

- E. Furnish and install the new lamps as specified for all lighting fixtures installed under this project, and for all existing lighting fixtures reused under this project.
- F. The electrical and ceiling trades shall coordinate to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges, etc.), to match the ceiling system being installed.
- G. Bond lighting fixtures to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- H. At completion of project, replace all defective components of the lighting fixtures at no cost to the Government.
- I. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT, and Section 02 41 00, DEMOLITION.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform the following:
 - 1. Visual Inspection:
 - a. Verify proper operation by operating the lighting controls.
 - b. Visually inspect for damage to fixtures, lenses, reflectors, diffusers, and louvers. Clean fixtures, lenses, reflectors, diffusers, and louvers that have accumulated dust, dirt, or fingerprints during construction.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting systems are in good operating condition and properly performing the intended function.

---END---

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of exterior fixtures, poles, and supports. The terms "lighting fixtures", "fixture" and "luminaire" are used interchangeably.

1.2 RELATED WORK

- A. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage power and lighting wiring.
- 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.
- E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings, and boxes for raceway systems.
- F. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground handholes and conduits.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
1. Shop Drawings:
 - a. Submit the following information for each type of lighting fixture designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of lighting fixture designation.
 - b. Material and construction details include information on housing and optics system.
 - c. Physical dimensions and description.
 - d. Wiring schematic and connection diagram.
 - e. Installation details.
 - f. Energy efficiency data.
 - g. Photometric data based on laboratory tests complying with IES Lighting Measurements testing and calculation guides.

- h. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours), and color temperature (degrees Kelvin).
- i. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts, and total harmonic distortion (THD).
- j. For LED lighting fixtures, submit US DOE LED Lighting Facts label, and IES L70 rated life.

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 Association of State Highway and Transportation Officials (AASHTO):
 - LRFDLTS-17STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS
- C. American Concrete Institute (ACI):
 - 318-14BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE
- D. American National Standards Institute (ANSI):
 - H35.1/H35 1M-17AMERICAN NATIONAL STANDARD ALLOY AND TEMPER DESIGNATION SYSTEMS FOR ALUMINUM
- E. American Society for Testing and Materials (ASTM):
 - A123/A123M-17ZINC (HOT-DIP GALVANIZED) COATINGS ON IRON AND STEEL PRODUCTS
 - A153/A153M-16ZINC COATING (HOT-DIP) ON IRON AND STEEL HARDWARE
 - B108/B108M-15ALUMINUM-ALLOY PERMANENT MOLD CASTINGS
 - C1089-13SPUN CAST PRESTRESSED CONCRETE POLES
- F. Federal Aviation Administration (FAA):
 - AC 70/7460-IL-15OBSTRUCTION LIGHTING AND MARKING
 - AC 150/5345-43H-16OBSTRUCTION LIGHTING EQUIPMENT
- G. Illuminating Engineering Society of North America (IESNA):

- HB-9-00LIGHTING HANDBOOK
- RP-8-14ROADWAY LIGHTING
- LM-52-03PHOTOMETRIC MEASUREMENTS OF ROADWAY SIGN
INSTALLATIONS
- LM-72-97 (R2010)DIRECTIONAL POSITIONING OF PHOTOMETRIC DATA
- LM-79-08APPROVED METHOD FOR THE ELECTRICAL AND
PHOTOMETRIC MEASUREMENTS OF SOLID-STATE LIGHTING
PRODUCTS
- LM-80-15APPROVED METHOD FOR MEASURING LUMINOUS FLUX AND
COLOR MAINTENANCE OF LED PACKAGES, ARRAYS AND
MODULES
- TM-15-11LUMINAIRE CLASSIFICATION SYSTEM FOR OUTDOOR
LUMINAIRES
- H. National Electrical Manufacturers Association (NEMA):
- C78.41-16ELECTRIC LAMPS - GUIDELINES FOR LOW-PRESSURE
SODIUM LAMPS
- C78.42-09 (R2016)ELECTRIC LAMPS - GUIDELINES FOR HIGH-PRESSURE
SODIUM LAMPS
- C78.43-13ELECTRIC LAMPS - SINGLE-ENDED METAL-HALIDE
LAMPS
- C78.1381-98ELECTRIC LAMPS - 70-WATT M85 DOUBLE-ENDED
METAL-HALIDE LAMPS
- C81.61-17ELECTRICAL LAMP BASES - SPECIFICATIONS FOR
BASES (CAPS) FOR ELECTRIC LAMPS
- C82.4-17BALLASTS FOR HIGH-INTENSITY-DISCHARGE AND LOW-
PRESSURE SODIUM LAMPS (MULTIPLE-SUPPLY TYPE)
- C136.3-14FOR ROADWAY AND AREA LIGHTING EQUIPMENT -
LUMINAIRE ATTACHMENTS
- C136.17-05 (R2010) (S2017)ROADWAY AND AREA LIGHTING EQUIPMENT -
ENCLOSED SIDE-MOUNTED LUMINAIRES FOR
HORIZONTAL-BURNING HIGH-INTENSITY-DISCHARGE
LAMPS - MECHANICAL INTERCHANGEABILITY OF
REFRACTORS
- ICS 2-00 (R2005)CONTROLLERS, CONTACTORS AND OVERLOAD RELAYS
RATED 600 VOLTS
- ICS 6-93 (R2016)ENCLOSURES
- I. National Fire Protection Association (NFPA):
- 70-17NATIONAL ELECTRICAL CODE (NEC)
- 101-18LIFE SAFETY CODE
- J. Underwriters Laboratories, Inc. (UL):

496-17	.....LAMP HOLDERS
773-16	.....PLUG-IN, LOCKING TYPE PHOTOCONTROLS FOR USE WITH AREA LIGHTING
773A-16	.....NONINDUSTRIAL PHOTOELECTRIC SWITCHES FOR LIGHTING CONTROL
1029-94	.....HIGH-INTENSITY-DISCHARGE LAMP BALLASTS
1598-08	.....LUMINAIRES
8750-15	.....LIGHT EMITTING DIODE (LED) EQUIPMENT FOR USE IN LIGHTING PRODUCTS

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Provide manufacturer's standard provisions for protecting pole finishes during transport, storage, and installation. Do not store poles on ground. Store poles so they are at least 305 mm (12 inches) above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Luminaires, materials, and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the drawings and specified.

2.2 POLES

A. General:

1. Pole shall be standard size approximately 20 feet height.
2. The pole and arm assembly shall be designed for wind loading of 161 km/hr (100 mph) minimum, as required by wind loading conditions at project site, with an additional 30% gust factor and supporting luminaire(s) and accessories such as shields, banner arms, and banners that have the effective projected areas indicated. The effective projected area of the pole shall be applied at the height of the pole base, as shown on the drawings.
3. Poles shall be anchor-bolt type designed for use with underground supply conductors. Poles shall have handhole having a minimum clear opening of 65 x 125 mm (2.5 x 5 inches). Handhole covers shall be secured by stainless steel captive screws.
4. Provide a base cover that matches the pole in material and color to conceal the mounting hardware pole-base welds and anchor bolts.
5. Hardware and Accessories: All necessary hardware and specified accessories shall be the product of the pole manufacturer.
6. Provide manufacturer's standard finish, as scheduled on the drawings.

B. Types:

1. Aluminum: Provide round aluminum poles manufactured of corrosion-resistant AA AAH35.1 aluminum alloys conforming to AASHTO LTS-4. Poles shall be seamless extruded or spun seamless type.

2.3 FOUNDATIONS FOR POLES

- A. Foundations shall be cast-in-place concrete, having 3000 psi minimum 28-day compressive strength.
- B. Foundations shall support the effective projected area of the specified pole, arm(s), luminaire(s), and accessories, such as shields, banner arms, and banners, under wind conditions previously specified in this section.
- C. Place concrete in spirally wrapped treated paper forms for round foundations, and construct forms for square foundations.
- D. Rub-finish and round all above-grade concrete edges to approximately 6 mm (0.25-inch) radius.
- E. Anchor bolt assemblies and reinforcing of concrete foundations shall be as shown on the drawings. Anchor bolts shall be in a welded cage or properly positioned by the tie wire to stirrups.

2.4 LUMINAIRES

- A. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, and safe cleaning and relamping.
- B. Illumination distribution patterns, BUG ratings and cutoff types as defined by the IESNA shall be as shown on the drawings.
- C. Incorporate ballasts in the luminaire housing, except where otherwise shown on the drawings.
- D. Lenses shall be frame-mounted, heat-resistant, borosilicate glass, with prismatic refractors, unless otherwise shown on the drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Pre-wire internal components to terminal strips at the factory.
- F. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.
- G. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- H. Provide manufacturer's standard finish.
- I. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

2.5 LAMPS

- A. Install the proper lamps in every luminaire installed as shown on the drawings.
- B. Lamps shall be general-service, outdoor lighting types.
- C. LED sources shall meet the following requirements:
 - 1. Operating temperature rating shall be between -40 degrees C (-40 degrees F) and 50 degrees C (120 degrees F).
 - 2. Correlated Color Temperature (CCT): 5000K

3. Color Rendering Index (CRI): ≥ 85 .
4. The manufacturer shall have performed reliability tests on the LEDs luminaires complying with Illuminating Engineering Society (IES) LM79 for photometric performance and LM80 for lumen maintenance and L70 life.

2.6 LED DRIVERS

- A. LED drivers shall meet the following requirements:
 1. Drivers shall have a minimum efficiency of 85%.
 2. Starting Temperature: -40 degrees C (-40 degrees F).
 3. Input Voltage: 120 to 480 ($\pm 10\%$) volt.
 4. Power Supplies: Class I or II output.
 5. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 μ s, 10kA/8 x 20 μ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
 6. Power Factor (PF): ≥ 0.90 .
 7. Total Harmonic Distortion (THD): $\leq 20\%$.
 8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
 9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

2.7 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Solid state, with dry contacts rated for 1800 VA tungsten or 1000 VA inductive, complying with UL 773A.
 1. Light-Level Monitoring Range: 16.14 to 108 lx (1.5 to 10 fc), with adjustable turn-on and turn-off levels.
 2. Time Delay: 15-second minimum.
 3. Surge Protection: Metal-oxide varistor.
 4. Mounting: Twist lock, with base-and-stem mounting or stem-and-swivel mounting accessories as required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lighting in accordance with the NEC, as shown on the drawings, and in accordance with manufacturer's recommendations.
- B. Pole Foundations:
 1. Excavate only as necessary to provide sufficient working clearance for installation of forms and proper use of tamper to the full depth of the excavation. Prevent surface water from flowing into the excavation. Thoroughly compact backfill with compacting arranged to

- prevent pressure between conductor, jacket, or sheath, and the end of conduit.
2. Set anchor bolts according to anchor-bolt templates furnished by the pole manufacturer.
 3. Install poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.
 4. After the poles have been installed, shimmed, and plumbed, grout the spaces between the pole bases and the concrete base with non-shrink concrete grout material. Provide a plastic or copper tube, of not less than 9 mm (0.375-inch) inside diameter through the grout, tight to the top of the concrete base to prevent moisture weeping from the interior of the pole.
- C. Install lamps in each luminaire.
- D. Adjust luminaires that require field adjustment or aiming.

3.2 GROUNDING

- A. Ground noncurrent-carrying parts of equipment, including metal poles, luminaires, mounting arms, brackets, and metallic enclosures, as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable and listed for this purpose.

3.3 ACCEPTANCE CHECKS AND TESTS

- A. Verify operation after installing luminaires and energizing circuits.

- - - E N D - - -

SECTION 27 05 11**REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS (INCLUDES CONTROL)****PART 1 - GENERAL****1.1 DESCRIPTION**

1. This section includes common requirements to communications and control installations and applies to all sections of Division 27
2. Provide completely functioning communications systems.
3. Comply with VAAR 852.236.91 and FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.
4. The extent of this article covers various systems and specific application will apply based on the specific system supplied.

1.2 REFERENCES

1. Abbreviations and Acronyms
 - A. Refer to <http://www.cfm.va.gov/til/sdetail.asp> for Division 00, ARCHITECTURAL ABBREVIATIONS.
 - B. Additional Abbreviations and Acronyms:

A	Ampere
AC	Alternating Current
AE	Architect and Engineer
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
AWG	American Wire Gauge (refer to STP and UTP)
AWS	Advanced Wireless Services
BCT	Bonding Conductor for Telecommunications (also Telecommunications Bonding Conductor (TBC))
BDA	Bi-Directional Amplifier
BICSI	Building Industry Consulting Service International
BIM	Building Information Modeling
BOM	Bill of Materials
BTU	British Thermal Units

BUCR	Back-up Computer Room
BTS	Base Transceiver Station
CAD	AutoCAD
CBOPC	Community Based Out-Patient Clinic
CBC	Coupled Bonding Conductor
CBOC	Community Based Out-Patient Clinic (refer to CBOPC, OPC, VAMC)
CCS	TIP's Cross Connection System (refer to VCCS and HCCS)
CFE	Contractor Furnished Equipment
CFM	US Department of Veterans Affairs Office of Construction and Facilities Management
CFR	Consolidated Federal Regulations
CIO	Communication Information Officer (Facility, VISN or Region)
cm	Centimeters
CO	Central Office
COR	Contracting Officer Representative
CPU	Central Processing Unit
CSU	Customer Service Unit
CUP	Conditional Use Permit(s) - Federal/GSA for VA
dB	Decibel
dBm	Decibel Measured
dBmV	Decibel per milli-Volt
DC	Direct Current
DEA	United States Drug Enforcement Administration
DSU	Data Service Unit
EBC	Equipment Bonding Conductor
ECC	Engineering Control Center (refer to DCR, EMCR)
EDGE	Enhanced Data (Rates) for GSM Evolution
EDM	Electrical Design Manual

EMCR	Emergency Management Control Room (refer to DCR, ECC)
EMI	Electromagnetic Interference (refer to RFI)
EMS	Emergency Medical Service
EMT	Electrical Metallic Tubing or thin wall conduit
ENTR	Utilities Entrance Location (refer to DEMARC, POTS, LEC)
EPBX	Electronic Digital Private Branch Exchange
ESR	Vendor's Engineering Service Report
FA	Fire Alarm
FAR	Federal Acquisition Regulations in Chapter 1 of Title 48 of Code of Federal Regulations
FMS	VA's Headquarters or Medical Center Facility's Management Service
FR	Frequency (refer to RF)
FTS	Federal Telephone Service
GFE	Government Furnished Equipment
GPS	Global Positioning System
GRC	Galvanized Rigid Metal Conduit
GSM	Global System (Station) for Mobile
HCCS	TIP's Horizontal Cross Connection System (refer to CCS & VCCS)
HDPE	High Density Polyethylene Conduit
HDTV	Advanced Television Standards Committee High-Definition Digital Television
HEC	Head End Cabinets (refer to HEIC, PA)
HEIC	Head End Interface Cabinets (refer to HEC, PA)
HF	High Frequency (Radio Band; Re FR, RF, VHF & UHF)
HSPA	High Speed Packet Access
HZ	Hertz
IBT	Intersystem Bonding Termination (NEC 250.94)
IC	Intercom

ICRA	Infectious Control Risk Assessment
IDEN	Integrated Digital Enhanced Network
IDC	Insulation Displacement Contact
IDF	Intermediate Distribution Frame
ILSM	Interim Life Safety Measures
IMC	Rigid Intermediate Steel Conduit
IRM	Department of Veterans Affairs Office of Information Resources Management
ISDN	Integrated Services Digital Network
ISM	Industrial, Scientific, Medical
IWS	Intra-Building Wireless System
LAN	Local Area Network
LBS	Location Based Services, Leased Based Systems
LEC	Local Exchange Carrier (refer to DEMARC, PBX & POTS)
LED	Light Emitting Diode
LMR	Land Mobile Radio
LTE	Long Term Evolution, or 4G Standard for Wireless Data Communications Technology
M	Meter
MAS	Medical Administration Service
MATV	Master Antenna Television
MCR	Main Computer Room
MCOR	Main Computer Operators Room
MDF	Main Distribution Frame
MH	Manholes or Maintenance Holes
MHz	Megahertz (10^6 Hz)
mm	Millimeter
MOU	Memorandum of Understanding
MW	Microwave (RF Band, Equipment or Services)
NID	Network Interface Device (refer to DEMARC)
NEC	National Electric Code

NOR	Network Operations Room
NRTL	OSHA Nationally Recognized Testing Laboratory
NS	Nurse Stations
NTIA	U.S. Department of Commerce National Telecommunications and Information Administration
OEM	Original Equipment Manufacturer
OI&T	Office of Information and Technology
OPC	VA's Outpatient Clinic (refer to CBOC, VAMC)
OSH	Department of Veterans Affairs Office of Occupational Safety and Health
OSHA	United States Department of Labor Occupational Safety and Health Administration
OTDR	Optical Time-Domain Reflectometer
PA	Public Address System (refer to HE, HEIC, RPEC)
PBX	Private Branch Exchange (refer to DEMARC, LEC, POTS)
PCR	Police Control Room (refer to SPCC, could be designated SCC)
PCS	Personal Communications Service (refer to UPCS)
PE	Professional Engineer
PM	Project Manager
PoE	Power over Ethernet
POTS	Plain Old Telephone Service (refer to DEMARC, LEC, PBX)
PSTN	Public Switched Telephone Network
PSRAS	Public Safety Radio Amplification Systems
PTS	Pay Telephone Station
PVC	Poly-Vinyl Chloride
PWR	Power (in Watts)
RAN	Radio Access Network
RBB	Rack Bonding Busbar
RE	Resident Engineer or Senior Resident Engineer

RF	Radio Frequency (refer to FR)
RFI	Radio Frequency Interference (refer to EMI)
RFID	RF Identification (Equipment, System or Personnel)
RMC	Rigid Metal Conduit
RMU	Rack Mounting Unit
RPEC	Radio Paging Equipment Cabinets (refer to HEC, HEIC, PA)
RTLS	Real Time Location Service or System
RUS	Rural Utilities Service
SCC	Security Control Console (refer to PCR, SPCC)
SMCS	Spectrum Management and Communications Security (COMSEC)
SFO	Solicitation for Offers
SME	Subject Matter Experts (refer to AHJ)
SMR	Specialized Mobile Radio
SMS	Security Management System
SNMP	Simple Network Management Protocol
SPCC	Security Police Control Center (refer to PCR, SMS)
STP	Shielded Balanced Twisted Pair (refer to UTP)
STR	Stacked Telecommunications Room
TAC	VA's Technology Acquisition Center, Austin, Texas
TCO	Telecommunications Outlet
TER	Telephone Equipment Room
TGB	Telecommunications Grounding Busbar (also Secondary Bonding Busbar (SBB))
TIP	Telecommunications Infrastructure Plant
TMGB	Telecommunications Main Grounding Busbar (also Primary Bonding Busbar (PBB))
TMS	Traffic Management System
TOR	Telephone Operators Room
TP	Balanced Twisted Pair (refer to STP and UTP)

TR	Telecommunications Room (refer to STR)
TWP	Twisted Pair
UHF	Ultrahigh Frequency (Radio)
UMTS	Universal Mobile Telecommunications System
UPCS	Unlicensed Personal Communications Service (refer to PCS)
UPS	Uninterruptible Power Supply
USC	United States Code
UTP	Unshielded Balanced Twisted Pair (refer to TP and STP)
UV	Ultraviolet
V	Volts
VAAR	Veterans Affairs Acquisition Regulation
VACO	Veterans Affairs Central Office
VAMC	VA Medical Center (refer to CBOC, OPC, VACO)
VCCS	TIP's Vertical Cross Connection System (refer to CCS and HCCS)
VHF	Very High Frequency (Radio)
VISN	Veterans Integrated Services Network (refers to geographical region)
VSWR	Voltage Standing Wave Ratio
W	Watts
WEB	World Electronic Broadcast
WiMAX	Worldwide Interoperability (for MW Access)
WI-FI	Wireless Fidelity
WMTS	Wireless Medical Telemetry Service
WSP	Wireless Service Providers

2. Definitions:

- A. Access Floor: Pathway system of removable floor panels supported on adjustable pedestals to allow cable placement in area below.

- B. BNC Connector (BNC): United States Military Standard MIL-C-39012/21 bayonet-type coaxial connector with quick twist mating, and two lugs preventing accidental disconnection from pulling forces on cable.
- C. Bond: Permanent joining of metallic parts to form an electrically conductive path to ensure electrical continuity and capacity to safely conduct any currents likely to be imposed to earth ground.
- D. Bundled Micro ducts: All forms of jacketed micro ducts.
- E. Conduit: Includes all raceway types specified.
- F. Conveniently Accessible: Capable of being reached without use of ladders, or without climbing or crawling under or over obstacles such as, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- G. Effectively Grounded: Intentionally bonded to earth through connections of low impedance having current carrying capacity to prevent buildup of currents and voltages resulting in hazard to equipment or persons.
- H. Electrical Supervision: Analyzing a system's function and components (i.e. cable breaks / shorts, inoperative stations, lights, LEDs and states of change, from primary to backup) on a 24/7/365 basis; provide aural and visual emergency notification signals to minimum two remote designated or accepted monitoring stations.
- I. Electrostatic Interference (ESI) or Electrostatic Discharge Interference: Refer to EMI and RFI.
- J. Project 25 (2014) (P25 (TIA-102 Series)): Set of standards for local, state and Federal public safety organizations and agencies digital LMR services. P25 is applicable to LMR equipment authorized or licensed under the US Department of Commerce National Telecommunications and Information Administration or FCC rules and regulations and is a required standard capability for all LMR equipment and systems.
- K. Grounding Electrode Conductor: (GEC) Conductor connected to earth grounding electrode.
- L. Grounding Electrode System: Electrodes through which an effective connection to earth is established, including supplementary, communications system grounding electrodes and GEC.

- M. Grounding Equalizer or Backbone Bonding Conductor (BBC): Conductor that interconnects elements of telecommunications grounding infrastructure.
- N. Head End (HE): Equipment, hardware and software, or a master facility at originating point in a communications system designed for centralized communications control, signal processing, and distribution that acts as a common point of connection between equipment and devices connected to a network of interconnected equipment, possessing greatest authority for allowing information to be exchanged, with whom other equipment is subordinate.
- O. Micro ducts: All forms of air blown fiber pathways.
- P. Ohm: A unit of resistive measurement.
- Q. Received Signal Strength Indication (RSSI): A measurement of power present in a received RF signal.
- R. Service Provider Demarcation Point (SPDP): Not owned by LEC or service provider but designated by Government as point within facility considered the DEMARC.
- S. Sound (SND): Changing air pressure to audible signals over given time span.
- T. System: Specific hardware, firmware, and software, functioning together as a unit, performing task for which it was designed.
- U. Telecommunications Bonding Backbone (TBB): Conductors of appropriate size (minimum 53.49 mm² [1/0 AWG]) stranded copper wire, that connect to Grounding Electrode System and route to telecommunications main grounding busbar (TMGB) and circulate to interconnect various TGBs and other locations shown on drawings.
- V. Voice over Internet Protocol (VoIP): A telephone system in which voice signals are converted to packets and transmitted over LAN network using Transmission Control Protocol (TCP)/Internet Protocol (IP). VA'S VoIP is not listed or coded for life and public safety, critical, emergency or other protection functions. When VoIP system or equipment is provided instead of PBX system or equipment, each TR (STR) and DEMARC requires increased AC power provided to compensate for loss of PBX's telephone instrument line power; and, to compensate for absence of PBX's UPS capability.

W. Wide Area Network (WAN): A digital network that transcends localized LANs within a given geographic location. VA'S WAN/LAN is not nationally listed or coded for life and public safety, critical, emergency or other safety functions.\

1.3 APPLICABLE PUBLICATIONS

1. Applicability of Standards: Unless documents include more stringent requirements, applicable construction industry standards have same force and effect as if bound or copied directly into the documents to extent referenced. Such standards are made a part of these documents by reference.

A. Each entity engaged in construction must be familiar with industry standards applicable to its construction activity.

B. Obtain standards directly from publication source, where copies of standards are needed to perform a required construction activity.

2. Government Codes, Standards and Executive Orders: Refer to

<http://www.cfm.va.gov/TIL/cPro.asp>:

A. Federal Communications Commission, (FCC) CFR, Title 47:

Part 15	Restrictions of use for Part 15 listed RF Equipment in Safety of Life Emergency Functions and Equipment Locations
Part 47	Chapter A, Paragraphs 6.1-6.23, Access to Telecommunications Service, Telecommunications Equipment and Customer Premises Equipment
Part 58	Television Broadcast Service
Part 73	Radio and Television Broadcast Rules
Part 90	Rules and Regulations, Appendix C
Form 854	Antenna Structure Registration
Chapter XXIII	National Telecommunications and Information Administration (NTIA, P/O Commerce, Chapter XXIII) the 'Red Book'- Chapters 7, 8 & 9 compliments CFR, Title 47, FCC Part 15, RF Restriction of Use and Compliance in "Safety of Life" Functions & Locations

B. US Department of Agriculture, (Title 7, USC, Chapter 55, Sections 2201, 2202 & 2203: RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction:

RUS Bull 1751F-630 Design of Aerial Cable Plants
 RUS Bull 1751F-640 Design of Buried Cable Plant, Physical Considerations
 RUS Bull 1751F-643 Underground Plant Design
 RUS Bull 1751F-815 Electrical Protection of Outside Plants,
 RUS Bull 1753F-201 Acceptance Tests of Telecommunications Plants (PC-4)
 RUS Bull 1753F-401 Splicing Copper and Fiber Optic Cables (PC-2)
 RUS Bull 345-50 Trunk Carrier Systems (PE-60)
 RUS Bull 345-65 Shield Bonding Connectors (PE-65)
 RUS Bull 345-72 Filled Splice Closures (PE-74)
 RUS Bull 345-83 Gas Tube Surge Arrestors (PE-80)

C. US Department of Commerce/National Institute of Standards Technology, (NIST):

FIPS PUB 1-1 Telecommunications Information Exchange
 FIPS PUB 100/1 Interface between Data Terminal Equipment (DTE) Circuit Terminating Equipment for operation with Packet Switched Networks, or Between Two DTEs, by Dedicated Circuit
 FIPS PUB 140/2 Telecommunications Information Security Algorithms
 FIPS PUB 143 General Purpose 37 Position Interface between DTE and Data Circuit Terminating Equipment
 FIPS 160/2 Electronic Data Interchange (EDI),
 FIPS 175 Federal Building Standard for Telecommunications Pathway and Spaces
 FIPS 191 Guideline for the Analysis of Local Area Network Security
 FIPS 197 Advanced Encryption Standard (AES)
 FIPS 199 Standards for Security Categorization of Federal Information and Information Systems

D. US Department of Defense, (DoD):

- MIL-STD-188-110 Interoperability and Performance Standards for Data Modems
- MIL-STD-188-114 Electrical Characteristics of Digital Interface Circuits
- MIL-STD-188-115 Communications Timing and Synchronizations Subsystems
- MIL-C-28883 Advanced Narrowband Digital Voice Terminals
- MIL-C-39012/21 Connectors, Receptacle, Electrical, Coaxial, Radio Frequency, (Series BNC (Uncabled), Socket Contact, Jam Nut Mounted, Class 2)
- E. US Department of Health and Human Services:
The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy, Security and Breach Notification Rules
- F. US Department of Justice:
2010 Americans with Disabilities Act Standards for Accessible Design (ADAAD).
- G. US Department of Labor, (DoL) - Public Law 426-62 - CFR, Title 29, Part 1910, Chapter XVII - Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards):
- Subpart 7 Approved NRTLs; obtain a copy at http://www.osha.gov/dts/otpca/nrtl/faq_nrtl.htm
1)
 - Subpart 35 Compliance with NFPA 101, Life Safety Code
 - Subpart 36 Design and Construction Requirements for Exit Routes
 - Subpart 268 Telecommunications
 - Subpart 305 Wiring Methods, Components, and Equipment for General Use
 - Subpart 508 Americans with Disabilities Act Accessibility Guidelines; technical requirement for accessibility to buildings and facilities by individuals with disabilities
- H. US Department of Transportation, (DoT):
Public Law 85-625, CFR, Title 49, Part 1, Subpart C - Federal Aviation Administration (FAA):AC 110/460-ID & AC 707 / 460-2E -

Advisory Circulars Standards for Construction of Antenna Towers,
and 7450 and 7460-2 - Antenna Construction Registration Forms.

- I. US Department of Veterans Affairs (VA): Office of Telecommunications (OI&T), MP-6, PART VIII, TELECOMMUNICATIONS, CHAPTER 5, AUDIO, RADIO AND TELEVISION (and COMSEC) COMMUNICATIONS SYSTEMS: Spectrum Management and COMSEC Service (SMCS), AHJ for:
 - a. CoG, "Continuance of Government" communications guidelines and compliance.
 - b. COMSEC, "VA wide coordination and control of security classified communication assets."
 - c. COOP, "Continuance of Operations" emergency communications guidelines and compliance.
 - d. FAA, FCC, and US Department of Commerce National Telecommunications and Information Administration, "VA wide RF Coordination, Compliance and Licensing."
 - e. Handbook 6100 - Telecommunications: Cyber and Information Security Office of Cyber and Information Security, and Handbook 6500 - Information Security Program.
 - f. Low Voltage Special Communications Systems "Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance and Life Safety Certifications for CFM and VA Facility Low Voltage Special Communications Projects (except Fire Alarm, Telephone and Data Systems)."
 - g. SATCOM, "Satellite Communications" guidelines and compliance, and Security and Law Enforcement Systems - "Coordinates the Design, Engineering, Construction Contract Specifications and Drawings Conformity, Proof of Performance Testing, VA Compliance, DEA and Public Safety Certification(s) for CFM and VA Facility Security Low Voltage Special Communications and Physical Security Projects.
 - h. VHA's National Center for Patient Safety - Veterans Health Administration (VHA) Warning System, Failure of Medical Alarm Systems using Paging Technology to Notify Clinical Staff, July 2004.
 - i. VA's CEOSH, concurrence with warning identified in VA Directive 7700.

- j. Wireless and Handheld Devices, "Guidelines and Compliance,"
- k. Office of Security and Law Enforcement: VA Directive 0730 and Health Special Presidential Directive (HSPD)-12.
- J. NRTL Standards: Refer to
<https://www.osha.gov/dts/otpca/nrtl/index.html>
- K. Canadian Standards Association (CSA); same tests as presented by UL
- L. Communications Certifications Laboratory (CEL); same tests as presented by UL.
- M. Intertek Testing Services NA, Inc., (ITSNA), formerly Edison Testing Laboratory (ETL) same tests as presented by UL).
- N. Underwriters Laboratory (UL):
 - 1-2005 Flexible Metal Conduit
 - 5-2011 Surface Metal Raceway and Fittings
 - 6-2007 Rigid Metal Conduit
 - 44-010 Thermoset-Insulated Wires and Cables
 - 50-1995 Enclosures for Electrical Equipment
 - 65-2010 Wired Cabinets
 - 83-2008 Thermoplastic-Insulated Wires and Cables
 - 96-2005 Lightning Protection Components
 - 96A-2007 Installation Requirements for Lightning Protection Systems
 - 360-2013 Liquid-Tight Flexible Steel Conduit
 - 444-2008 Communications Cables
 - 467-2013 Grounding and Bonding Equipment
 - 486A-486B-2013 Wire Connectors
 - 486C-2013 Splicing Wire Connectors
 - 486D-2005 Sealed Wire Connector Systems
 - 486E-2009 Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
 - 493-2007 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
 - 497/497A/497B/497C
 - 497D/497E Protectors for Paired Conductors/Communications Circuits/Data Communications and Fire Alarm Circuits/coaxial circuits/voltage protections/Antenna Lead In

510-2005	Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
514A-2013	Metallic Outlet Boxes
514B-2012	Fittings for Cable and Conduit
514C-1996	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-2011	Schedule 40 and 80 Rigid PVC Conduit
651A-2011	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-2007	Electrical Metallic Tubing
884-2011	Underfloor Raceways and Fittings
1069-2007	Hospital Signaling and Nurse Call Equipment
1242-2006	Intermediate Metal Conduit
1449-2006	Standard for Transient Voltage Surge Suppressors
1479-2003	Fire Tests of Through-Penetration Fire Stops
1480-2003	Speaker Standards for Fire Alarm, Emergency, Commercial and Professional use
1666-2007	Standard for Wire/Cable Vertical (Riser) Tray Flame Tests
1685-2007	Vertical Tray Fire Protection and Smoke Release Test for Electrical and Fiber Optic Cables
1861-2012	Communication Circuit Accessories
1863-2013	Standard for Safety, communications Circuits Accessories
1865-2007	Standard for Safety for Vertical-Tray Fire Protection and Smoke-Release Test for Electrical and Optical-Fiber Cables
2024-2011	Standard for Optical Fiber Raceways
2024-2014	Standard for Cable Routing Assemblies and Communications Raceways
2196-2001	Standard for Test of Fire Resistive Cable
60950-1 ed. 2-2014	Information Technology Equipment Safety

PART 2 - INDUSTRY STANDARDS:

2.1 ADVANCED TELEVISION SYSTEMS COMMITTEE (ATSC) :

A/53 Part 1: 2013	ATSC Digital Television Standard, Part 1, Digital Television System
A/53 Part 2: 2011	ATSC Digital Television Standard, Part 2, RF/Transmission System Characteristics
A/53 Part 3: 2013	ATSC Digital Television Standard, Part 3, Service Multiplex and Transport System Characteristics
A/53 Part 4: 2009	ATSC Digital Television Standard, Part 4, MPEG- 2 Video System Characteristics
A/53 Part 5: 2014	ATSC Digital Television Standard, Part 5, AC-3 Audio System Characteristics
A/53 Part 6: 2014	ATSC digital Television Standard, Part 6, Enhanced AC-3 Audio System Characteristics

2.2 AMERICAN INSTITUTE OF ARCHITECTS (AIA): 2006 GUIDELINES FOR DESIGN & CONSTRUCTION OF HEALTH CARE FACILITIES.**2.3 AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) :**

A17.1 (2013)	Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices
17.3 (2011)	Safety Code for Existing Elevators and Escalators
17.4 (2009)	Guide for Emergency Personnel
17.5 (2011)	Elevator and Escalator Electrical Equipment

2.4 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) :

B1 (2001)	Standard Specification for Hard-Drawn Copper Wire
B8 (2004)	Standard Specification for Concentric-Lay- Stranded Copper Conductors, Hard, Medium-Hard, or Soft
D1557 (2012)	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft ³ (2,700 kN-m/m ³)

D2301 (2004)	Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
B258-02 (2008)	Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors
D709-01 (2007)	Standard Specification for Laminated Thermosetting Materials
D4566 (2008)	Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable
A. American Telephone and Telegraph Corporation (AT&T) - Obtain following AT&T Publications at https://ebiznet.sbc.com/SBCNEBS/):	
ATT-TP-76200 (2013)	Network Equipment and Power Grounding, Environmental, and Physical Design Requirements
ATT-TP-76300 (2012)	Merged AT&T Affiliate Companies Installation Requirements
ATT-TP-76305 (2013)	Common Systems Cable and Wire Installation and Removal Requirements - Cable Racks and Raceways
ATT-TP-76306 (2009)	Electrostatic Discharge Control
ATT-TP-76400 (2012)	Detail Engineering Requirements
ATT-TP-76402 (2013)	AT&T Raised Access Floor Engineering and Installation Requirements
ATT-TP-76405 (2011)	Technical Requirements for Supplemental Cooling Systems in Network Equipment Environments
ATT-TP-76416 (2011)	Grounding and Bonding Requirements for Network Facilities
ATT-TP-76440 (2005)	Ethernet Specification
ATT-TP-76450 (2013)	Common Systems Equipment Interconnection Standards for AT&T Network Equipment Spaces
ATT-TP-76461 (2008)	Fiber Optic Cleaning
ATT-TP-76900 (2010)	AT&T Installation Testing Requirement
ATT-TP-76911 (1999)	AT&T LEC Technical Publication Notice

2.5 BRITISH STANDARDS INSTITUTION (BSI) :

BS EN 50109-2 Hand Crimping Tools - Tools for The Crimp Termination of Electric Cables and Wires for Low Frequency and Radio Frequency Applications - All Parts & Sections. October 1997

2.6 BUILDING INDUSTRY CONSULTING SERVICE INTERNATIONAL (BICSI) :

ANSI/BICSI 002-2011 Data Center Design and Implementation Best Practices

ANSI/BICSI 004-2012 Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities

ANSI/NECA/BICSI
568-2006 Standard for Installing Commercial Building Telecommunications Cabling

NECA/BICSI 607-2011 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings

ANSI/BICSI 005-2013 Electronic Safety and Security (ESS) System Design and Implementation Best Practices

A. Electronic Components Assemblies and Materials Association, (ECA).
ECA EIA/RS-270 (1973) Tools, Crimping, Solderless Wiring Devices - Recommended Procedures for User Certification
EIA/ECA 310-E (2005) Cabinets, and Associated Equipment

B. Facility Guidelines Institute: 2010 Guidelines for Design and Construction of Health Care Facilities.

C. Insulated Cable Engineers Association (ICEA):

ANSI/ICEA
S-80-576-2002 Category 1 & 2 Individually Unshielded Twisted-Pair Indoor Cables for Use in Communications Wiring Systems

ANSI/ICEA
S-84-608-2010 Telecommunications Cable, Filled Polyolefin Insulated Copper Conductor, S-87-640 (2011)
Optical Fiber Outside Plant Communications Cable

ANSI/ICEA

S-90-661-2012	Category 3, 5, & 5e Individually Unshielded Twisted-Pair Indoor Cable for Use in General Purpose and LAN Communication Wiring Systems
S-98-688 (2012)	Broadband Twisted Pair Cable Aircore, Polyolefin Insulated, Copper Conductors
S-99-689 (2012)	Broadband Twisted Pair Cable Filled, Polyolefin Insulated, Copper Conductors
ICEA S-102-700 (2004)	Category 6 Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for use in Communications Wiring Systems Technical Requirements

2.7 INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) :

ISSN 0739-5175	March-April 2008 Engineering in Medicine and Biology Magazine, IEEE (Volume: 27, Issue:2) Medical Grade-Mission Critical-Wireless Networks
IEEE C2-2012 C62.41.2-2002/ Cor 1-2012 IEEE	National Electrical Safety Code (NESC) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits 4)
C62.45-2002	IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
81-2012 IEEE	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
100-1992	IEEE the New IEEE Standards Dictionary of Electrical and Electronics Terms
602-2007	IEEE Recommended Practice for Electric Systems in Health Care Facilities
1100-2005	IEEE Recommended Practice for Powering and Grounding Electronic Equipment

A. International Code Council:

AC193 (2014)	Mechanical Anchors in Concrete Elements
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- B. International Organization for Standardization (ISO):
- ISO/TR 21730 (2007) Use of Mobile Wireless Communication and Computing Technology in Healthcare Facilities - Recommendations for Electromagnetic Compatibility (Management of Unintentional Electromagnetic Interference) with Medical Devices
- C. National Electrical Manufacturers Association (NEMA):
- NEMA 250 (2008) Enclosures for Electrical Equipment (1,000V Maximum)
 - ANSI C62.61 (1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits
 - ANSI/NEMA FB 1 (2012) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing EMT) and Cable
 - ANSI/NEMA OS 1 (2009) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
 - NEMA SB 19 (R2007) NEMA Installation Guide for Nurse Call Systems
 - TC 3 (2004) Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
 - NEMA VE 2 (2006) Cable Tray Installation Guidelines
- D. National Fire Protection Association (NFPA):
- 70E-2015 Standard for Electrical Safety in the Workplace
 - 70-2014 National Electrical Code (NEC)
 - 72-2013 National Fire Alarm Code
 - 75-2013 Standard for the Fire Protection of Information Technological Equipment
 - 76-2012 Recommended Practice for the Fire Protection of Telecommunications Facilities
 - 77-2014 Recommended Practice on Static Electricity
 - 90A-2015 Standard for the Installation of Air Conditioning and Ventilating Systems
 - 99-2015 Health Care Facilities Code
 - 101-2015 Life Safety Code
 - 241 Safeguarding construction, alternation and Demolition Operations

255-2006	Standard Method of Test of Surface Burning Characteristics of Building Materials
262 - 2011	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
780-2014	Standard for the Installation of Lightning Protection Systems
1221-2013	Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
5000-2015	Building Construction and Safety Code

2.8 SOCIETY FOR PROTECTIVE COATINGS (SSPC) :

SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning

2.9 SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE) :

ANSI/SCTE 15 2006 Specification for Trunk, Feeder and Distribution Coaxial Cable

2.10 TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA) :

TIA-120 Series	Telecommunications Land Mobile communications (APCO/Project 25) (January 2014)
TIA TSB-140	Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems (2004)
TIA-155	Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T (2010)
TIA TSB-162-A	Telecommunications Cabling Guidelines for Wireless Access Points (2013)
TIA-222-G	Structural Standard for Antenna Supporting Structures and Antennas (2014)
TIA/EIA-423-B	Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits (2012)
TIA-455-C	General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and other Fiber Optic Components (August 2014)

TIA-455-53-A FOTP-53 Attenuation by Substitution
Measurements for Multimode Graded-Index Optical
Fibers in Fiber Assemblies (Long Length)
(September 2001)

TIA-455-61-A FOTP-61 Measurement of Fiber of Cable
Attenuation Using an OTDR (July 2003)

TIA-472D000-B Fiber Optic Communications Cable for Outside
Plant Use (July 2007)

ANSI/TIA-492-B 62.5- μ Core Diameter/125- μ m Cladding Diameter
Class 1a Graded-Index Multimode Optical Fibers
(November 2009)

ANSI/TIA-492AAAB-A 50- μ m Core Diameter/125- μ m Cladding Diameter
Class IA Graded-Index Multimode Optically
Optimized American Standard Fibers (November
2009)

TIA-492CAAA Detail Specification for Class IVa Dispersion-
Unshifted Single-Mode Optical Fibers (September
2002)

TIA-492E000 Sectional Specification for Class IVd Nonzero-
Dispersion Single-Mode Optical Fibers for the
1,550 nm Window (September 2002)

TIA-526-7-B Measurement of Optical Power Loss of Installed
Single-Mode Fiber Cable Plant - OFSTP-7
(December 2008)

TIA-526.14-A Optical Power Loss Measurements of Installed
Multimode Fiber Cable Plant - SFSTP-14 (August
1998)

TIA-568 Revision/Edition: C Commercial Building
Telecommunications Cabling Standard Set: (TIA-
568-C.0-2 Generic Telecommunications Cabling
for Customer Premises (2012), TIA-568-C.1-1
Commercial Building Telecommunications Cabling
Standard Part 1: General Requirements (2012),
TIA-568-C.2 Commercial Building
Telecommunications Cabling Standard-Part 2:
Balanced Twisted Pair Cabling Components

(2009), TIA-568-C.3-1 Optical Fiber Cabling Components Standard, (2011) AND TIA-568-C.4 Broadband Coaxial Cabling and Components Standard (2011) with addendums and erratas

TIA-569 Revision/Edition C Telecommunications Pathways and Spaces (March 2013)

TIA-574 Position Non-Synchronous Interface between Data Terminal equipment and Data Circuit Terminating Equipment Employing Serial Binary Interchange (May 2003)

TIA/EIA-590-A Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant (July 2001)

TIA-598-D Optical Fiber Cable Color Coding (January 2005)

TIA-604-10-B Fiber Optic Connector Intermateability Standard (August 2008)

ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure (2012)

TIA-607-B Generic Telecommunications Bonding and Grounding (Earthing) For Customer Premises (January 2013)

TIA-613 High Speed Serial Interface for Data Terminal Equipment and Data Circuit Terminal Equipment (September 2005)

ANSI/TIA-758-B Customer-owned Outside Plant Telecommunications Infrastructure Standard (April 2012)

ANSI/TIA-854 A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling (2001)

ANSI/TIA-862-A Building Automation Systems Cabling Standard (April 2011)

TIA-942-A Telecommunications Infrastructure Standard for Data Centers (March 2014)

TIA-1152 Requirements for Field Testing Instruments and Measurements for Balanced Twisted Pair Cabling (September 2009)

TIA-1179

Healthcare Facility Telecommunications
Infrastructure Standard (July 2010)**2.11 SINGULAR NUMBER**

1. Where any device or part of equipment is referred in singular number (such as " rack"), reference applies to as many such devices as are required to complete installation.

2.12 RELATED WORK

1. Specification Order of Precedence: FAR Clause 52.236-21, VAAR Clause 852.236-71.
 - A. Additional submittal requirements: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
 - B. Availability and source of references and standards specified in applicable publications: Section 01 42 19, REFERENCE STANDARDS.
 - C. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction: Section 07 84 00, FIRESTOPPING.
 - D. Sealant and caulking materials and their application: Section 07 92 00, JOINT SEALANTS.
 - E. General electrical requirements that are common to more than one section of Division 26: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
 - F. Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
 - G. Conduit and boxes: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
 - H. Wiring devices: Section 26 27 26, WIRING DEVICES.

2.13 ADMINISTRATIVE REQUIREMENTS

1. Assign a single communications project manager to serve as point of contact for Government, contractor, and design professional.
2. Be proactive in scheduling work.
 - A. Use of premises is restricted at times directed by COR.
 - B. Movement of materials: Unload materials and equipment delivered to site.

- C. Coordinate installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - D. Sequence, coordinate, and integrate installations of materials and equipment for efficient flow of Work.
 - E. Coordinate connection of materials, equipment, and systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies; provide required connection for each service.
 - F. Initiate and maintain discussion regarding schedule for ceiling construction and install cables to meet that schedule.
3. Contact the Office of Telecommunications, Special Communications Team (0050P2H3) (202)461-5310 to have a Government-accepted Telecommunications COR assigned to project for telecommunications review, equipment and system approval and coordination with other VA personnel.
4. Communications Project Manager Responsibilities:
- A. Assume responsibility for overall telecommunications system integration and coordination of work among trades, subcontractors, and authorized system installers.
 - B. Coordinate with related work indicated on drawings or specified.
 - C. Manage work related to telecommunications system installation in a manner approved by manufacturer.

2.14 SUBMITTALS

- 1. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- 2. Provide parts list including quantity of spare parts.
- 3. Provide manufacturer product information. Government reserves the right to require a list of installations where products have been in operation.
- 4. Provide Source Quality Control Submittal:
 - A. Submit written certification from OEM indicating that proposed supervisor of installation and proposed provider of warranty maintenance are authorized representatives of OEM. Include

individual's legal name, contact information and OEM credentials in certification.

- B. Submit written certification from OEM that wiring and connection diagrams meet Government Life Safety Guidelines, NFPA, NEC, NRTL, these specifications, and Joint Commission requirements and instructions, requirements, recommendations, and guidance set forth by OEM for the proper performance of system.
- C. Pre-acceptance Certification: Certification in accordance with procedure outlined in Section 01 00 00, GENERAL REQUIREMENTS and specific Division 27 qualification documentation.

2.15 INSTALLER QUALIFICATIONS:

- 1. Submit three installations of similar size and complexity furnished and installed by installer; include:
 - A. Installation location and name.
 - B. Owner's name and contact information including address, telephone and email.
 - C. Date of project start and date of final acceptance.
 - D. System project number.
 - E. Three paragraph description of each system related to this project; include function, operation, and installation.

2.16 TEST EQUIPMENT LIST:

- A. Supply test equipment of accuracy better than parameters to be tested.
- B. Submit test equipment list including make and model number:
 - a. ANSI/TIA-1152 Level IV twisted pair cabling test instrument.
 - b. Fiber optic insertion loss power meter with light source.
 - c. Optical time domain reflectometer (OTDR).
 - d. Volt-Ohm meter.
 - e. Digital camera.
- C. Supply only test equipment with a calibration tag from Government-accepted calibration service dated not more than 12 months prior to test.
- D. Provide sample test and evaluation reports. G. Submittal Drawings:

- E. Telecommunications Space Plans/Elevations: Provide enlarged floor plans of telecommunication spaces indicating layout of equipment and devices, including receptacles and grounding provisions. Submit detailed plan views and elevations of telecommunication spaces showing racks, termination blocks, and cable paths. Include following rooms:
 - a. Equipment rooms.
- F. Logical Drawings: Provide logical riser or schematic drawings for all systems.
 - a. Provide riser diagrams systems and interconnection drawings for equipment assemblies; show termination points and identify wiring connections.
- G. Access Panel Schedule on Submittal Drawings: Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment.
- H. Provide sustainable design submittals.
- I. Furnish electronic certified test reports to COR prior to final inspection and not more than 90 days after completion of tests.

2.17 CLOSEOUT SUBMITTALS

1. Provide following closeout submittals prior to project closeout date:
 - A. Warranty certificate.
 - B. Evidence of compliance with requirements such as low voltage certificate of inspection.
 - C. Project record documents.
 - D. Instruction manuals and software that are a part of system.
2. Maintenance and Operation Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
 - A. Prepare a manual for each system and equipment specified.
 - B. Furnish on portable storage drive in PDF format or equivalent accepted by COR.
 - C. Furnish complete manual as specified in specification section, fifteen days prior to performance of systems or equipment test.
 - D. Furnish remaining manuals prior to final completion.
 - E. Identify storage drive "MAINTENANCE AND OPERATION MANUAL" and system name.

- F. Include name, contact information and emergency service numbers of each subcontractor installing system or equipment and local representatives for system or equipment.
- G. Provide a Table of Contents and assemble files to conform to Table of Contents.
- H. Operation and Maintenance Data includes:
 - a. Approved shop drawing for each item of equipment.
 - b. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of equipment.
 - c. A control sequence describing start-up, operation, and shutdown.
 - d. Description of function of each principal item of equipment.
 - e. Installation and maintenance instructions.
 - f. Safety precautions.
 - g. Diagrams and illustrations.
 - h. Test Results and testing methods.
 - i. Performance data.
 - j. Pictorial "exploded" parts list with part numbers. Emphasis to be placed on use of special tools and instruments. Indicate sources of supply, recommended spare parts, and name of servicing organization.
 - k. Warranty documentation indicating end date and equipment protected under warranty.
 - l. Appendix; list qualified permanent servicing organizations for support of equipment, including addresses and certified personnel qualifications.
- C. Record Wiring Diagrams:
 - 1. Red Line Drawings: Keep one E size 91.44 cm x 121.92 cm (36 inches x 48 inches) set of floor plans, on site during work hours, showing installation progress marked and backbone cable labels noted. Make these drawings available for examination during construction meetings or field inspections.
 - 2. General Drawing Specifications: Detail and elevation drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches). ER, TR and other enlarged detail floor plan drawings to be D size 61 cm x 91.44 cm (24" x 36") with a minimum scale of 0.635 cm = 30.48 cm (1/4 inch = 12 inches).

Building composite floor plan drawings to be D size 61 cm x 91.44 cm (24 inches x 36 inches) with a minimum scale of 3.175 mm = 30.48 cm (1/8 inch = 1' 0 inch).

3. Building Composite Floor Plans: Provide building floor plans showing work area outlet locations and configuration, types of jacks, distance for each cable, and cable routing locations.
 4. Floor plans to include:
 - a. Final room numbers and actual backbone cabling and pathway locations and labeling.
 - b. Inputs and outputs of equipment identified according to labels installed on cables and equipment
 - c. Device locations with labels.
 - d. Conduit.
 - e. Head-end equipment.
 - f. Wiring diagram.
 - g. Labeling and administration documentation.
 5. Submit Record Wiring Diagrams within five business days after final cable testing.
 6. Deliver Record Wiring Diagrams as CAD files in .dwg or .rvt formats as determined by COR.
 7. Deliver four complete sets of electronic record wiring diagrams to COR on portable storage drive.
- D. Service Qualifications: Submit name and contact information of service organizations providing service to this installation within four hours of receipt of notification service is needed.

2.18 MAINTENANCE MATERIAL SUBMITTALS

1. After approval and prior to installation, furnish COR with the following:
 - A. A 300 mm (12 inch) length of each type and size of wire and cable along with tag from coils of reels from which samples were taken.
 - B. One coupling, bushing and termination fitting for each type of conduit.
 - C. Samples of each hanger, clamp and supports for conduit and pathways.
 - D. Duct sealing compound.

2.19 QUALITY ASSURANCE

1. Manufacturer's Qualifications: Manufacturer must produce, as a principal product, the equipment and material specified for this project, and have manufactured item for at least three years.
- B. Product and System Qualification:
 - A. OEM must have three installations of equipment submitted presently in operation of similar size and type as this project, that have continuously operated for a minimum of three years.
 - B. Government reserves the right to require a list of installations where products have been in operation before approval.
 - C. Authorized representative of OEM must be responsible for design, satisfactory operation of installed system, and certification.
- C. Trade Contractor Qualifications: Trade contractor must have completed three or more installations of similar systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identify these installations as a part of submittal.
- D. System Supplier Qualifications: System supplier must be authorized by OEM to warranty installed equipment.
- E. Telecommunications technicians assigned to system must be trained and certified by OEM on installation and testing of system; provide written evidence of current OEM certifications for installers.
- F. Manufactured Products:
 1. Comply with FAR clause 52.236-5 for material and workmanship.
 2. When more than one unit of same class of equipment is required, units must be product of a single manufacturer.
 3. Equipment Assemblies and Components:
 - a. Components of an assembled unit need not be products of same manufacturer.
 - b. Manufacturers of equipment assemblies, which include components made by others, to assume complete responsibility for final assembled unit.
 - c. Provide compatible components for assembly and intended service.
 - d. Constituent parts which are similar must be product of a single manufacturer.

D. Identify factory wiring on equipment being furnished and on wiring diagrams.

7. Testing Agencies: Government reserves the option of witnessing factory tests. Notify COR minimum 15 working days prior to manufacturer performing the factory tests.

A. When equipment fails to meet factory test and re-inspection is required, contractor is liable for additional expenses, including expenses of Government.

2.20 DELIVERY, STORAGE, AND HANDLING

1. Delivery and Acceptance Requirements:

A. Government's approval of submittals must be obtained for equipment and material before delivery to job site.

B. Deliver and store materials to job site in OEM's original unopened containers, clearly labeled with OEM's name and equipment catalog numbers, model and serial identification numbers for COR to inventory cable, patch panels, and related equipment.

2. Storage and Handling Requirements:

A. Equipment and materials must be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:

a. Store and protect equipment in a manner that precludes damage or loss, including theft.

b. Protect painted surfaces with factory installed removable heavy kraft paper, sheet vinyl or equivalent.

c. Protect enclosures, equipment, controls, controllers, circuit protective devices, and other like items, against entry of foreign matter during installation; vacuum clean both inside and outside before testing and operating.

C. Coordinate storage.

2.21 FIELD CONDITIONS

A. Where variations from documents are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, connecting work and related components must include additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

- B. A contract adjustment or additional time will not be granted because of field conditions pursuant to FAR 52.236-2 and FAR 52.236-3; a contract adjustment or additional time will not be granted for additional work required for complete and usable construction and systems pursuant to FAR 52.246-12.

2.22 WARRANTY

- 1. Comply with FAR clause 52.246-21
 - A. Warranty material and equipment to be free from defects, workmanship, and remain so for a period of one year for Emergency Systems from date of final acceptance of system by Government; provide OEM's equipment warranty document to COR.
 - B. Government maintenance personnel must have ability to contact OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time; contractor and OEM must provide this capability.

PART 3 - PRODUCTS

3.1 PERFORMANCE AND DESIGN CRITERIA

- 1. Provide communications spaces and pathways conforming to TIA 569, at a minimum.
- 2. Modification to administrative issues requires written approvals from COR with concurrence from SMCS 0050P2H3, OEM, contractor, and local authorities.

3.2 EQUIPMENT IDENTIFICATION

- 1. Provide laminated black phenolic resin with a white core nameplate with minimum 6 mm (1/4 inch) high engraved lettering.
- 2. Nameplates furnished by manufacturer as standard catalog items unless other method of identification is indicated.

3.3 UNDERGROUND WARNING TAPE - (NOT USED)

3.4 WIRE LUBRICATING COMPOUND

- 1. Provide non-hardening or forming adhesive coating cable lubricants suitable for cable jacket material and raceway.

3.5 FIREPROOFING TAPE

1. Provide flexible, conformable fabric tape of organic composition and coated one side with flame-retardant elastomer.
2. Tape must be self-extinguishing and cannot support combustion; arc-proof and fireproof.
3. Tape cannot deteriorate when subjected to water, gases, salt water, sewage, or fungus; and tape must be resistant to sunlight and ultraviolet light.
4. Application must withstand a 200-ampere arc for minimum 30 seconds.
5. Securing Tape: Glass cloth electrical tape minimum 0.18 mm (7 mils) thick and 19 mm (3/4 inch) wide.

PART 4 - EXECUTION

4.1 PREPARATION

1. Penetrations and Sleeves:
 - A. Lay out penetration and sleeve openings in advance, to permit provision in work.
 - B. Set sleeves in forms before concrete is poured.
 - C. Set sleeves prior to installation of structure for passage of pipes, conduit, ducts, etc.
 - D. Provide sleeves and packing materials at penetrations of foundations, walls, slabs, partitions, and floors.
 - E. Make sleeves that penetrate outside walls, basement slabs, footings, and beams waterproof.
 - F. Fill slots, sleeves and other openings in floors or walls if not used.
 - a. Fill spaces in openings after installation of conduit or cable.
 - b. Provide fill for floor penetrations to prevent passage of water, smoke, fire, and fumes.
 - c. Provide fire resistant fill in rated floors and walls, to prevent passage of air, smoke and fumes.
 - G. Install sleeves through floors watertight and extend minimum 50.8 mm (2 inches) above floor surface.
 - H. Match and set sleeves flush with adjoining floor, ceiling, and wall finishes where raceways passing through openings are exposed in finished rooms.

- I. Annular space between conduit and sleeve must be minimum 6 mm (1/4 inch).
 - J. Do not provide sleeves for slabs-on-grade, unless specified or indicated otherwise.
 - K. Comply with requirements for firestopping, for sleeves through rated fire walls and smoke partitions.
 - L. Do not support piping risers or conduit on sleeves.
 - M. Identify unused sleeves and slots for future installation.
 - N. Provide core drilling if walls are poured or otherwise constructed without sleeves and wall penetration is required; do not penetrate structural members.
2. Core Drilling:
- A. Avoid core drilling whenever possible.
 - B. Coordinate openings with other trades and utilities and prevent damage to structural reinforcement.
 - C. Investigate existing conditions in vicinity of required opening prior to coring, including an x-ray of floor if determined necessary by competent person or COR.
 - D. Protect areas from damage.
3. Verification of In-Place Conditions:
- A. Verify location, use and status of all material, equipment, and utilities that are specified, indicated, or determined necessary for removal.
 - a. Verify materials, equipment, and utilities to be removed are inactive, not required, or in use after completion of project.
 - b. Replace with equivalent any material, equipment and utilities that were removed by contractor that are required to be left in place.
 - B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Government or others unless permitted under following conditions and then only after arranging to provide temporary utility services, according to requirements indicated:
 - a. Notify COR in writing at least 14 days in advance of proposed utility interruptions.
 - b. Do not proceed with utility interruptions without Government's written permission.

4. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall and ceiling mounting of equipment as required.
5. Provide steel supports and hardware for installation of hangers, anchors, guides, and other support hardware.
6. Obtain and analyze catalog data, weights, and other pertinent data required for coordination of equipment support provisions and installation.
7. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that would void warranty.

4.2 INSTALLATION - GENERAL

1. Coordinate systems, equipment, and materials installation with other building components.
2. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
3. Conform to VAAR 852.236.91 arrangements indicated, recognizing that work may be shown in diagrammatic form or have been impracticable to detail all items because of variances in manufacturers' methods of achieving specified results.
4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed in both exposed and un-exposed spaces.
5. Install equipment according to manufacturers' written instructions.
6. Install wiring and cabling between equipment and related devices.
7. Install cabling, wiring, and equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum interference of adjacent other installations.
8. Provide access panel or doors where units are concealed behind finished surfaces.
9. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for wiring, cabling, and equipment installations.

10. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom and access for service and maintenance as possible.
11. Install systems, materials, and equipment giving priority to systems required to be installed at a specified slope.
12. Avoid interference with structure and with work or other trades, preserving adequate headroom and clearing doors and passageways to satisfaction of COR and code requirements.
13. Install equipment and cabling to distribute equipment loads on building structural members provided for equipment support under other sections; install and support roof-mounted equipment on structural steel or roof curbs as appropriate.
14. Provide supplementary or miscellaneous items, appurtenances, devices and materials for a complete installation.

4.3 EQUIPMENT INSTALLATION

1. Locate equipment as close as practical to locations shown on drawings.
2. Note locations of equipment requiring access on record drawings.
3. Access and Access Panels: Verify access panel locations and construction with COR.
4. Inaccessible Equipment:
 - A. Where Government determines that contractor has installed equipment not conveniently accessible for operation and maintenance, equipment must be removed and reinstalled as directed and without additional cost to Government.

4.4 EQUIPMENT IDENTIFICATION

1. Install an identification sign which clearly indicates information required for use and maintenance of equipment.
2. Secure identification signs with screws.

4.5 CUTTING AND PATCHING

1. Perform cutting and patching according to contract general requirements and as follows:
 - A. Remove samples of installed work as specified for testing.
 - B. Perform cutting, fitting, and patching of equipment and materials required to uncover existing infrastructure in order to provide access for correction of improperly installed existing or new work.

- C. Remove and replace defective work.
- D. Remove and replace non-conforming work.
- 2. Cut, remove, and legally dispose of selected equipment, components, and materials, including removal of material, equipment, devices, and other items indicated to be removed and items made obsolete by new work.
- 3. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
- 4. Protect adjacent installations during cutting and patching operations.
- 5. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- 6. Patch finished surfaces and building components using new materials specified for original installation and experienced installers.

4.6 FIELD QUALITY CONTROL

- 1. Provide work according to VAAR 852.236.91 and FAR clause 52.236-5.
- 2. Provide minimum clearances and work required for compliance with NFPA 70, National Electrical Code (NEC), and manufacturers' instructions; comply with additional requirements indicated for access and clearances.
- 3. Verify all field conditions and dimensions that affect selection and provision of materials and equipment, and provide any disassembly, reassembly, relocation, demolition, cutting and patching required to provide work specified or indicated, including relocation and reinstallation of existing wiring and equipment.
 - A. Protect facility, equipment, and wiring from damage.
- 4. Submit written notice that:
 - A. Project has been inspected for compliance with documents.
 - B. Work has been completed in accordance with documents.
- 5. Non-Conforming Work: Conduct project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing and demonstrations after verification of system operation and completeness by Contractor.
- 6. For project acceptance inspections, final completion inspections, substantial completion inspections, and testing/demonstrations that require more than one site visit by COR or design professional to

verify project compliance for same material or equipment, Government reserves right to obtain compensation from contractor to defray cost of additional site visits that result from project construction or testing deficiencies and incompleteness, incorrect information, or non-compliance with project provisions.

- A. COR will notify contractor, of hourly rates and travel expenses for additional site visits and will issue an invoice to Contractor for additional site visits.
 - B. Contractor is not be eligible for extensions of project schedule or additional charges resulting from additional site visits that result from project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions.
7. Tests:
- A. Interim inspection is required at approximately 50 percent of installation.
 - B. Request inspection ten working days prior to interim inspection start date by notifying COR in writing; this inspection must verify equipment and system being provided adheres to installation, mechanical and technical requirements of construction documents.
 - C. Inspection to be conducted by OEM and factory-certified contractor representative, and witnessed by COR, facility and SMCS 0050P2H3 representatives.
 - D. Check each item of installed equipment to ensure appropriate NRTL listing labels and markings are fixed in place.
 - E. Verify cabling terminations in DEMARC, MCR, TER, SCC, ECC, TRs and head end rooms, workstation locations and TCO adhere to color code for T568B pin assignments and cabling connections are following TIA standards.
 - F. Visually confirm minimum Category 6 cable marking at TCOs, CCSs locations, patch cords and origination locations.
 - G. Review entire communications circulating ground system, each TGB and grounding connection, grounding electrode and outside lightning protection system.
 - H. Review cable tray, conduit and path/wire way installation practice.
 - I. OEM and contractor to perform:

- a. Fiber optical cable field inspection tests via attenuation measurements on factory reels; provide results along with OEM certification for factory reel tests.
 - b. Coaxial cable field inspection tests via attenuation measurements on factory reels; provide results along with OEM certification for factory reel tests.
 - c. Baseband cable field inspection tests via attenuation measurements on factory reels and provide results along with OEM certification for factory reel tests.
- J. Relocate failed cable reels to a secured location for inventory, as directed by COR, and then remove from project site within two working days; provide COR with written confirmation of defective cable reels removal from project site.
- K. Provide results of interim inspections to COR.
- L. If major or multiple deficiencies are discovered, additional interim inspections could be required until deficiencies are corrected, before permitting further system installation.
- a. Additional inspections are scheduled at direction of COR.
 - b. Re-inspection of deficiencies noted during interim inspections, must be part of system's Final Acceptance Proof of Performance Test.
 - c. The interim inspection cannot affect the system's completion date unless directed by COR.
- M. Facility COR will ensure test documents become a part of system's official documentation package.
8. Pretesting: Re-align, re-balance, sweep, re-adjust and clean entire system and leave system working for a "break-in" period, upon completing installation of system and prior to Final Acceptance Proof of Performance Test. System RF transmitting equipment must not be connected to keying or control lines during "break-in" period.
- A. Pretesting Procedure:
- a. Verify systems are fully operational and meet performance requirements, utilizing accepted test equipment and spectrum analyzer.
 - b. Pretest and verify system functions and performance requirements conform to construction documents and, that no unwanted physical,

aural and electronic effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise are present.

- B. Measure and record signal, aural and control carrier levels of each DAS RF, voice and data channel, at each of the following minimum points in system:
 - a. Utility provider entrance.
 - b. Buried conduit duct locations.
 - c. Maintenance Holes (Manholes) and hand holes.
 - d. ENTR or DEMARC.
 - e. PBX interconnections.
 - f. MCR interconnections.
 - g. MCOR interconnections.
 - h. TER interconnections.
 - i. TOR interconnections.
 - j. Control room interconnections.
 - k. TR interconnections.
 - l. System interfaces in locations listed herein.
 - m. HE interconnections.
 - n. Antenna (outside and inside) interconnections.
 - o. System and lightning ground interconnections.
 - p. Communications circulating ground system.
 - q. UPS areas.
 - r. Emergency generator interconnections.
 - s. Each general floor areas.
 - t. Others as required by AHJ (SMCS 0050P2H3).
 - C. Provide recorded system pretest measurements and certification that the system is ready for formal acceptance test to COR.
9. Acceptance Test:
- A. Schedule an acceptance test date after system has been pretested, and pretest results and certification submitted to COR.
 - B. Give COR fifteen working days written notice prior to date test is expected to begin; include expected duration of time for test in notification.
 - C. Test in the presence of the following:
 - a. COR.
 - b. OEM representatives.

- c. VACO:
 - 1) CFM representative.
 - 2) AHJ-SMCS 0050P2H3, (202)461-5310.
- d. VISN-CIO, Network Officer and VISN representatives.
- e. Facility:
 - 1) FMS Service Chief, Bio-Medical Engineering and facility representatives.
 - 2) OI&T Service Chief and OI&T representatives.
 - 3) Safety Officer, Police Chief and facility safety representatives.
- f. Local Community Safety Personnel:
 - 1) Fire Marshal representative.
 - 2) Disaster Coordinator representative.
 - 3) EMS Representatives: Police, Sherriff, City, County or State representatives.
- D. Test system utilizing accepted test equipment to certify proof of performance and Life and Public Safety compliance, FCC, NRTL, NFPA and OSHA compliance.
 - a. Rate system as acceptable or unacceptable at conclusion of test; make only minor adjustments and connections required to show proof of performance.
 - 1) Demonstrate and verify that system complies with performance requirements under operating conditions.
 - 2) Failure of any part of system that precludes completion of system testing, and which cannot be repaired within four hours, terminates acceptance test of that portion of system.
 - 3) Repeated failures that result in a cumulative time of eight hours to affect repairs is cause for entire system to be declared unacceptable.
 - 4) If system is declared unacceptable, retesting must be rescheduled at convenience of Government and costs borne by the contractor.
- 10. Acceptance Test Procedure:
 - A. Physical and Mechanical Inspection: The test team representatives must tour major areas to determine system and sub-systems are

completely and properly installed and are ready for acceptance testing.

- B. A system inventory including available spare parts must be taken at this time.
 - C. Each item of installed equipment must be re-checked to ensure appropriate NRTL (i.e. UL) certification listing labels are affixed.
 - D. Confirm that deficiencies reported during Interim Inspections and Pretesting are corrected prior to start of Acceptance Test.
 - E. Inventory system diagrams, record drawings, equipment manuals, pretest results.
 - F. Failure of system to meet installation requirements of specifications is grounds for terminating testing and to schedule re-testing.
11. Acceptance Test Conclusion: Reschedule testing on deficiencies and shortages with COR, after COR and SMCS AHJ jointly agree to results of the test, using the generated punch list or discrepancy list. Perform retesting to comply with these specifications at contractor's expense.
12. Proof of Performance Certification:
- A. If system is declared acceptable, AHJ (SMCS 0050P2H3) provides COR notice stating system processes to required operating standards and functions and is Government accepted for use by facility.
 - B. Validate items with COR needing to be provided to complete project contract (i.e. charts & diagrams, manuals, spare parts, system warranty documents executed, etc.). Once items have been provided, COR contacts FMS service chief to turn over system from CFM oversight for beneficial use by facility.
 - C. If system is declared unacceptable without conditions, rescheduled testing expenses are to be borne by contractor.

4.7 CLEANING

- 1. Remove debris, rubbish, waste material, tools, construction equipment, machinery and surplus materials from project site and clean work area, prior to final inspection and acceptance of work.
- 2. Put building and premises in neat and clean condition.
- 3. Remove debris daily.
- 4. Remove unused material, during progress of work.

5. Perform cleaning and washing required to provide acceptable appearance and operation of equipment to satisfaction of COR.
6. Clean exterior surface of all equipment, including concrete residue, dirt, and paint residue, after completion of project.
7. Perform final cleaning prior to project acceptance by COR.
8. Remove paint splatters and other spots, dirt, and debris; touch up scratches and mars of finish to match original finish.
9. Clean devices internally using methods and materials recommended by manufacturer.
10. Tighten wiring connectors, terminals, bus joints, and mountings, to include lugs, screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. In absence of published connection or terminal torque values, comply with torque values specified in UL 486A-486B.

4.8 TRAINING

1. Provide training in accordance with subsection, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.
2. Provide training for equipment or system as required in each associated specification.
3. Develop and submit training schedule for approval by COR, at least 30 days prior to planned training.

4.9 PROTECTION

1. Protection of Fireproofing:
 - A. Install clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed, if possible, prior to start of spray fireproofing work.
 - B. Install conduits and other items that would interfere with proper application of fireproofing after completion of spray fire proofing work.
 - C. Patch and repair fireproofing damaged due to cutting or course of work must be performed by installer of fireproofing and paid for by trade responsible for damage.
2. Maintain equipment and systems until final acceptance.

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3. Ensure adequate protection of equipment and material during installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

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SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section identifies common and general grounding and bonding requirements of communication installations and applies to all sections of Divisions 27.

1.2 RELATED WORK

A. Low voltage wiring: Controls

1.3 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Provide plan indicating location of system grounding electrode connections and routing of aboveground and underground grounding electrode conductors.
- C. Closeout Submittals: In addition to Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS provide the following:
 - 1. Certified test reports of ground resistance.
 - 2. Certifications: Two weeks prior to final inspection, submit following to COR:
 - a. Certification materials and installation is in accordance with construction documents.
 - b. Certification complete installation has been installed and tested.

PART 2 - PRODUCTS

2.1 COMPONENTS

- A. Grounding and Bonding Conductors:
 - 1. Provide UL 83 insulated stranded copper equipment grounding conductors, with the exception of solid copper conductors for sizes 6 mm² (10 AWG) and smaller. Identify all grounding conductors with continuous green insulation color, except identify wire sizes 25 mm² (4 AWG) and larger per NEC.

2. Provide ASTM B8 bare stranded copper bonding conductors, with the exception of ASTM B1 solid bare copper for wire sizes 6 mm² (10 AWG) and smaller.
- B. Ground Rods: - (NOT USED)
- C. Splices and Termination Components: Provide components meeting or exceeding UL 467 and clearly marked with manufacturer's name, catalog number, and permitted conductor sizes.
- D. Telecommunication System Ground Busbars: - (NOT USED)
- E. Equipment Rack and Cabinet Ground Bars: - (NOT USED)
- F. Ground Terminal Blocks: Provide screw lug-type terminal blocks at equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted.
1. Electroplated tin aluminum extrusion.
 2. Accept conductors ranging from #14 AWG through 2/0.
 3. Hold conductors in place by two stainless steel set screws.
 4. Two 6 mm (1/4 inch) holes spaced on 15.8 mm (5/8 inch) centers to allow secure two-bolt attachment.
 5. Listed as a wire connector.
- G. Splice Case Ground Accessories: Provide splice case grounding and bonding accessories manufactured by splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.
- H. Irreversible Compression Lugs:
1. Electroplated tinned copper.
 2. Two holes spaced on 15.8 mm (5/8 inch) or 25.4 mm (1 inch) centers.
 3. Sized to fit the specific size conductor.
 4. Listed as wire connectors.
- I. Antioxidant Joint Compound: Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Inaccessible Grounding Connections: Utilize exothermic welding for bonding of buried or otherwise inaccessible connections with the exception of connections requiring periodic testing.
- B. Conduit Systems:

1. Bond ferrous metallic conduit to ground.
2. Bond grounding conductors installed in ferrous metallic conduit at both ends of conduit using grounding bushing with #6 AWG conductor.

C. Boxes, Cabinets, and Enclosures:

1. Bond each pull box, splice box, equipment cabinet, and other enclosures through which conductors pass (except for special grounding systems for intensive care units and other critical units shown) to ground.

D. Corrosion Inhibitors: Apply corrosion inhibitor for protecting connection between metals used to contact surfaces, when making ground and ground bonding connections.

H. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near top of backboards used for communications cross-connect systems. Connect backboard ground terminals to cable runway using an insulated 16 mm² (6 AWG) bonding jumper.

I. Other Communication Room Ground Systems: Ground metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray or telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

J. Communications Cable Grounding:

1. Bond all metallic cable sheaths in multi-pair communications cables together at each splicing or terminating location to provide 100 percent metallic sheath continuity throughout communications distribution system.
2. Install a cable shield bonding connector with a screw stud connection for ground wire, at terminal points. Bond cable shield connector to ground.
3. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or splice case manufacturer's splice case grounding and bonding accessories. When an external ground connection is provided as part of splice closure, connect to an effective ground source and bond all other metallic components and equipment at that location.

K. Communications Cable Tray Systems:

1. Bond metallic structures of cable tray to provide 100 percent electrical continuity throughout cable tray systems.

2. Where metallic cable tray systems are mechanically discontinuous:
 - a. Install splice plates provided by cable tray manufacturer between cable tray sections so resistance across a bolted connection is 0.010 ohms or less, as verified by measuring across splice plate connection.
 - b. Install 16 mm² (6 AWG) bonding jumpers across each cable tray splice or junction where splice plates cannot be used.
3. Bond cable tray installed in same room as telecommunications grounding busbar to busbar.

L. Communications Raceway Grounding:

1. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to bond metallic conduit at both ends and intermediate metallic enclosures to ground.
2. Cable Tray Systems: Use insulated 16 mm² (6 AWG) grounding jumpers to bond cable tray to column-mounted building ground plates (pads) at both ends and approximately 16 meters (50 feet) on centers.

M. Ground Resistance:

1. Install telecommunications grounding system so resistance to grounding electrode system measures 5 ohms or less.
2. Measure grounding electrode system resistance using an earth test meter, clamp-on ground tester, or computer-based ground meter as defined in IEEE 81. Record ground resistance measurements before electrical distribution system is energized.
3. Backfill only after below-grade connection have been visually inspected by COR. Notify COR twenty-four hours before below-grade connections are ready for inspection.

3.2 FIELD QUALITY CONTROL

- A. Perform tests per BICSI's Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.
- B. Perform two-point bond test using trained installers qualified to use test equipment.
- C. Conduct continuity test to verify that metallic pathways in telecommunications spaces are bonded to TGB or TMGB.
- D. Conduct electrical continuity test to verify that TMGB is effectively bonded to grounding electrode conductor.

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- E. Visually inspect to verify that screened and shielded cables are bonded to TGB or TMGB.
- F. Perform a resistance test to ensure patch panel, rack and cabinet bonding connection resistance measures less than 5 Ohms to TGB or TMGB.

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SECTION 27 05 33**RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS (INCLUDES CONTROLS)****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. This section specifies conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for communications cabling unless shown or specified otherwise.

1.2 RELATED WORK

- A. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- B. Sealing around conduit penetrations through building envelope to prevent moisture migration into building: Section 07 92 00, JOINT SEALANTS.
- C. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

- A. Contractor to submit the following:
1. Size and location of cabinets, splice boxes and pull boxes.
 2. Layout of required conduit penetrations through structural elements.
 3. Catalog cuts marked with specific item proposed and area of application identified.
- B. Certification: Provide letter prior to final inspection, certifying material is in accordance with construction documents and properly installed.

PART 2 - PRODUCTS**2.1 MATERIAL**

- A. Minimum Conduit Size: 19 mm (3/4 inch).
- B. Conduit:
1. Rigid Galvanized Steel: Conform to UL 6, ANSI C80.1.
 2. Rigid Aluminum: Conform to UL 6A, ANSI C80.5.
 3. Rigid Intermediate Steel Conduit (IMC): Conform to UL 1242, ANSI C80.6.
 4. Electrical Metallic Tubing (EMT):

- a. Maximum Size: 105 mm (4 inches).
 - b. Install only for cable rated 600 volts or less.
 - c. Conform to UL 797, ANSI C80.3.
5. Flexible Galvanized Steel Conduit: Conform to UL 1.
 6. Liquid-tight Flexible Metal Conduit: Conform to UL 360.
 7. Direct Burial Plastic Conduit: Conform to UL 651 and UL 651A, heavy wall PVC, or high density polyethylene (HDPE).
 8. Surface Metal Raceway: Conform to UL 5.
 9. Wireway, Approved "Basket": Provide "Telecommunications Service" rated with approved length way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
- C. Conduit Fittings:
1. Rigid Galvanized Steel and Rigid Intermediate Steel Conduit Fittings:
 - a. Provide fittings meeting requirements of UL 514B and ANSI/ NEMA FB 1.
 - b. Sealing: Provide threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water and vapor. In concealed work, install sealing fittings in flush steel boxes with blank cover plates having same finishes as other electrical plates in room.
 - c. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - d. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
 - e. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into metallic body of fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - f. Erickson (union-type) and Set Screw Type Couplings:
 - 1) Couplings listed for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete.
 - 2) Use set screws of case hardened steel with hex head and cup point to seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.

- g. Provide OEM approved fittings.
- 2. Rigid Aluminum Conduit Fittings:
 - a. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Malleable iron, steel or aluminum alloy materials; Zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are not permitted.
 - b. Locknuts and Bushings: As specified for rigid steel and IMC conduit.
 - c. Set Screw Fittings: Not permitted for use with aluminum conduit.
- 3. Electrical Metallic Tubing Fittings:
 - a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
 - b. Couplings and Connectors: Concrete tight and rain tight, with connectors having insulated throats.
 - 1) Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller.
 - 2) Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches).
 - 3) Use set screws of case-hardened steel with hex head and cup point to seat in wall of conduit for positive grounding.
 - c. Indent type connectors or couplings are not permitted.
 - d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.
 - e. Provide OEM approved fittings.
- 4. Flexible Steel Conduit Fittings:
 - a. Conform to UL 514B; only steel or malleable iron materials are acceptable.
 - b. Provide clamp type, with insulated throat.
 - c. Provide OEM approved fittings.
- 5. Liquid-tight Flexible Metal Conduit Fittings:
 - a. Conform to UL 514B and ANSI/ NEMA FB1; only steel or malleable iron materials are acceptable.
 - b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
 - c. Provide connectors with insulated throats to prevent damage to cable jacket.

- d. Provide OEM approved fittings.
 - 6. Direct Burial Plastic Conduit Fittings: Provide fittings meeting requirements of UL 514C and NEMA TC3, and as recommended by conduit manufacturer.
 - 7. Surface Metal Raceway: Conform to UL 5 and "telecommunications service" rated with approved length-way partitions and cable straps to prevent wires and cables from changing from one partitioned pathway to another.
 - 8. Surface Metal Raceway Fittings: As recommended by raceway manufacturer.
 - 9. Expansion and Deflection Couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate 19 mm (3/4 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
 - c. Include internal flexible metal braid sized to ensure conduit ground continuity and fault currents in accordance with UL 467, and NEC code tables for ground conductors.
 - d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
 - 10. Rigid Aluminum Fittings:
 - a. Provide malleable iron, steel or aluminum alloy materials; zinc or cadmium plate iron or steel fittings. Aluminum fittings containing more than 0.4 percent copper are prohibited.
 - b. Locknuts and Bushings: As specified for rigid steel and IMC conduit.
 - c. Set Screw Fittings: Not permitted for use with aluminum conduit.
 - d. Indent type connectors or couplings are prohibited.
 - e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are not permitted.
 - f. Provide OEM approved fittings.
 - 11. Wireway Fittings: As recommended by wireway OEM.
- D. Conduit Supports:
- 1. Parts and Hardware: Provide zinc-coat or 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: Minimum 38 mm by 38 mm (1-1/2 by 1-1/2 inch), 2.78 mm (12 gage) steel, cold formed, lipped channels; with minimum 9 mm (3/8 inch) diameter steel hanger rods.
 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Splice, and Pull Boxes:
1. Conform to UL-50 and UL-514A.
 2. Cast metal where required by NEC or shown, and equipped with rustproof boxes.
 3. Sheet Metal Boxes: Galvanized steel, except where otherwise shown.
 4. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with wall.
 5. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.
- G. Flexible Nonmetallic Communications Raceway (Innerduct) and Fittings:
1. General: Provide UL 910 listed plenum, riser, and general purpose corrugated pliable communications raceway for optical fiber cables and communications cable applications; select in accordance with provisions of NEC Articles 770 and 800.
 2. Provide Communications Raceway with a factory installed 567 kg (1250 lb.) tensile pre-lubricated pull tape.
 3. Use only metallic straps, hangers and fittings to support raceway from building structure. Cable ties are not permitted for securing raceway to building structure.
 4. Provide fittings to be installed in spaces used for environmental air made of materials that do not exceed flammability, smoke generation, ignitibility, and toxicity requirements of environmental air space.
 5. Size: Metric Designator 53 (trade size 2) or smaller.
 6. Outside Plant: Plenum-rated where each interduct is 75 mm (3 inches) and larger.

7. Inside Plant: Listed and marked for installation in plenum airspaces and minimum 25 mm (1 inch) inside diameter.
 8. Plenum: Non-metallic communications raceway.
 - a. Constructed of low smoke emission, flame retardant PVC with corrugated construction.
 - b. UL 94 V-0 rating for flame spreading limitation.
 9. Provide innerduct reel lengths as necessary to ensure ducts are continuous; one piece runs from ENTR to MH; MH to MH; DEMARC to MCR/TER; TR to TR. Innerduct connectors are not permitted between rooms.
 10. Provide pulling accessories used for innerduct including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles (blown air) compatible with materials being pulled.
- H. Outlet Boxes:
1. Flush wall mounted minimum 11.9 cm (4-11/16 inches) square, 9.2 cm (3-5/8 inches) deep pressed galvanized steel.
 2. Flush wall mounted 12.7 cm (5 inches) square x 7.3 cm (2-7/8 inches); deep pressed galvanized steel.
 3. 2-Gang Tile Box:
 - a. Flush backbox type for installation in block walls.
 - b. Minimum 92 mm (3-5/8 inches) deep.
- I. Weatherproof Outlet Boxes: Surface mount two gang, 67 mm (2-5/8 inches) deep weatherproof cast aluminum with powder coated finish internal threads on hubs 19 mm (3/4 inch) minimum.
- J. Cable Tray:
1. Provide wire basket type of sizes indicated; with all required splicing and mounting hardware.
 2. Materials and Finishes:
 - a. Electro-plated zinc galvanized (post plated) made from carbon steel and plated to ASTM B 633, Type III, SC-1.
 - b. Remove soot, manufacturing residue/oils, or metallic particles after fabrication.
 - c. Rounded edges and smooth surfaces.
 3. Provide continuous welded top side wire to protect cable insulation and installers.

- 4. High strength steel wires formed into a 50 x 100 mm (2 inches by 4 inches) wire mesh pattern with intersecting wires welded together.
- 5. Fittings: Field-formed, from straight sections, in accordance with manufacturer's instructions.
- 6. Provide accessories to protect, support and install wire basket tray system.
- K. Cable Duct: Equip with hinged covers, except where removable covers are accepted by COR.
- L. Cable Duct Fittings: As recommended by cable duct OEM.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Raceways typically required for cabling systems unless otherwise indicated:

System	Specification Section	Installed Method
Grounding	27 05 26	Conduit Not Required
Control, Communication and Signal Wiring	27 10 00	Complete Conduit Allowed in Non-Partitioned Cable Tray or Cable Ladders

- B. Penetrations:

- 1. Cutting or Holes:

- a. Locate holes in advance of installation. Where they are proposed in structural sections, obtain approval of structural engineer and COR prior to drilling through structural sections.
- b. Make holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not permitted; COR may grant limited permission by request, in condition of limited working space.
- c. Fire Stop: Where conduits, wireways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an

effective barrier against spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

- 1) Fill and seal clearances between raceways and openings with fire stop material.
- 2) Install only retrofittable, non-hardening, and reusable firestop material that can be removed and reinstalled to seal around cables inside conduits.

d. Waterproofing at Floor, Exterior Wall, and Roof Conduit Penetrations:

- 1) Seal clearances around conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS

C. Conduit Installation:

1. Minimum conduit size of 19 mm (3/4 inch), but not less than size required for 40 percent fill.
2. Install insulated bushings on all conduit ends.
3. Install pull boxes after every 180 degrees of bends (two 90 degree bends). Size boxes per TIA 569.
4. Extend vertical conduits/sleeves through floors minimum 75 mm (3 inches) above floor and minimum 75 mm (3 inches) below ceiling of floor below.
5. Terminate conduit runs to and from a backboard in a closet or interstitial space at top or bottom of backboard. Install conduits to enter telecommunication rooms next to wall and flush with backboard.
6. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections.
7. Seal empty conduits located in telecommunications rooms or on backboards with a standard non-hardening putty compound to prevent entrance of moisture and gases and to meet fire resistance requirements.
8. Minimum radius of communication conduit bends:

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
3/4	150 (6)
1	230 (9)
1-1/4	350 (14)
1-1/2	430 (17)
2	525 (21)
2-1/2	635 (25)
3	775 (31)
3-1/2	900 (36)
4	1125 (45)

9. Provide 19 mm (3/4 inch) thick fire retardant plywood on wall of communication closets where shown on drawings. Mount plywood with bottom edge 300 mm (12 inches) above finished floor and top edge 2.74 m (9 feet) A.F.F.
10. Provide pull wire in all empty conduits; sleeves through floor are exceptions.
11. Complete each entire conduit run installation before pulling in cables.
12. Flattened, dented, or deformed conduit is not permitted.
13. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.
14. Cut conduit square with a hacksaw, ream, remove burrs, and draw tight.
15. Install conduit mechanically continuous.
16. Independently support conduit at 2.44 m (8 feet) on center; do not use other supports (i.e., suspended ceilings, suspended ceiling supporting members, luminaires, conduits, mechanical piping, or mechanical ducts).
17. Support conduit within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.

18. Close ends of empty conduit with plugs or caps to prevent entry of debris, until cables are pulled in.
 19. Attach conduits to cabinets, splice cases, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on inside of enclosure, made up wrench tight. Do not make conduit connections to box covers.
 20. Do not use aluminum conduits in wet locations.
 21. Unless otherwise indicated on drawings or specified herein, conceal conduits within finished walls, floors and ceilings.
 22. Conduit Bends:
 - a. Make bends with standard conduit bending machines; observe minimum bend radius for cable type and outside diameter.
 - b. Conduit hickey is permitted only for slight offsets, and for straightening stubbed conduits.
 - c. Bending of conduits with a pipe tee or vise is not permitted.
 23. Layout and Homeruns - Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted and approved by COR.
- D. Concealed Work Installation:
1. In Concrete:
 - a. Conduit: Rigid steel or IMC.
 - b. Align and run conduit in direct lines.
 - c. Install conduit through concrete beams only when the following occurs:
 - 1) Where shown on structural drawings.
 - 2) As accepted by COR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
 - d. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
 - 1) Conduit outside diameter larger than 1/3 of slab thickness is prohibited.
 - 2) Space between Conduits in Slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.

- 3) Install conduits approximately in center of slab to ensure a minimum of 19 mm (3/4 inch) of concrete around conduits.
 - e. Make couplings and connections watertight. Use thread compounds that are NRTL listed conductive type to ensure low resistance ground continuity through conduits. Tightening set screws with pliers is not permitted.
- E. Furred or Suspended Ceilings and in Walls:
1. Rigid steel, or rigid aluminum. Different type conduits mixed indiscriminately in same system is not permitted.
 2. Align and run conduit parallel or perpendicular to building lines.
 3. Tightening set screws with pliers is not permitted.
- F. Exposed Work Installation:
1. Unless otherwise indicated on drawings, exposed conduit is only permitted in telecommunications rooms.
 - a. Provide rigid steel, IMC or rigid aluminum.
 - b. Different type of conduits mixed indiscriminately in system is not permitted.
 2. Align and run conduit parallel or perpendicular to building lines.
 3. Install horizontal runs close to ceiling or beams and secure with conduit straps.
 4. Support horizontal or vertical runs at not over 2400 mm (96 inches) intervals.
 5. Surface Metal Raceways: Use only where shown on drawings.
 6. Painting:
 - a. Provide labels where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.
- G. Expansion Joints:
1. Conduits 75 mm (3 inches) and larger, that are secured to building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install couplings in accordance with manufacturer's recommendations.
 2. Provide conduits smaller than 75 mm (3 inches) with pull boxes on both sides of expansion joint. Connect conduits to expansion and deflection couplings as specified.
 3. Install expansion and deflection couplings where shown.
- H. Conduit Supports, Installation:

1. Select AC193 code listed mechanical anchors or fastening devices with safe working load not to exceed 1/4 of proof test load.
2. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.
3. Support multiple conduit runs with trapeze hangers. Use trapeze hangers designed to support a load equal or greater than sum of the weights of the conduits, wires, hanger itself, and 90 kg (200 pounds). Attach each conduit with U-bolts or other accepted fasteners.
4. Support conduit independent of pull boxes, luminaires, suspended ceiling components, angle supports, duct work, and similar items.
5. Fastenings and Supports in Solid Masonry and Concrete:
 - a. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing concrete.
 - b. Existing Construction:
 - 1) Code AC193 listed wedge type steel expansion anchors minimum 6 mm (1/4 inch) bolt size and minimum 28 mm (1-1/8 inch) embedment.
 - 2) Power set fasteners minimum 6 mm (1/4 inch) diameter with depth of penetration minimum 75 mm (3 inches).
 - 3) Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
6. Fastening to Hollow Masonry: Toggle bolts are permitted.
7. Fastening to Metal Structures: Use machine screw fasteners or other devices designed and accepted for application.
8. Bolts supported only by plaster or gypsum wallboard are not acceptable.
9. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
10. Do not support conduit from chain, wire, or perforated strap.
11. Spring steel type supports or fasteners are not permitted except horizontal and vertical supports/fasteners within walls.
12. Vertical Supports:

- a. Install riser clamps and supports for vertical conduit runs in accordance with NEC.
 - b. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.
- I. Box Installation:
1. Boxes for Concealed Conduits:
 - a. Flush mounted.
 - b. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
 2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables during pulling.
 3. 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.
 4. Stencil or install phenolic nameplates on covers of boxes identified on riser diagrams; for example "SIG-FA JB No. 1".
 5. Outlet boxes mounted back-to-back in same wall are not permitted. A minimum 600 mm (24 inches) center-to-center lateral spacing must be maintained between boxes.
- J. Flexible Nonmetallic Communications Raceway (Innerduct), Installation:
1. Install supports from building structure for horizontal runs at intervals not to exceed 900 mm (3 feet) and at each end.
 2. Install supports from building structure for vertical runs at intervals not to exceed 1.2 m (4 feet) and at each side of joints.
 3. Install only in accessible spaces not subject to physical damage or corrosive influences.
 4. Make bends manually to assure internal diameter of tubing is not effectively reduced.
 5. Extend each segment of innerduct minimum 300 mm (12 inches) beyond end of service conduit tie or cable tray. Restrain innerduct ends with wall mount clamps and seal when cable is installed.

3.2 TESTING

- A. Examine fittings and locknuts for secureness.
- B. Test RMC, IMC and EMT systems for electrical continuity.
- C. Perform simple continuity test after cable installation.

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SECTION 27 10 00
CONTROL, COMMUNICATION AND SIGNAL WIRING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes control, communication and signal wiring for a comprehensive systems infrastructure.
- B. This section applies to all sections of Divisions 27

1.2 RELATED WORK

- A. Sealing around penetrations to maintain 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.
- C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

- A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- B. Submit written certification from OEM:
 - 1. Indicate wiring and connection diagrams meet National and Government Life Safety Guidelines, NFPA, NEC, NRTL, Joint Commission, OEM, this section and Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
 - 2. Include instructions, requirements, recommendations, and guidance for proper performance of system as described herein.
 - 3. Government will not approve any submittal without this certification.
- C. Identify environmental specifications on technical submittals; identify requirements for installation.
 - 1. Minimum floor space and ceiling heights.
 - 2. Minimum size of doors for cable reel passage.

- D. Power: Provide specific voltage, amperage, phases, generator equipment and quantities of circuits.
- E. Provide conduit size requirements.
- F. Closeout Submittals:
 - 1. Provide contact information for maintenance personnel to contact contractor for emergency maintenance and logistic assistance, and assistance in resolving technical problems at any time during warranty period.
 - 2. Provide certified OEM sweep test tags from each cable reel to COR.
 - 3. Furnish spare or unused wire and cable with appropriate connectors (female types) for installation in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.
 - 4. Turn over unused and opened installation kit boxes, coaxial, fiber optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, physical installation hardware to COR.
 - 5. Documentation: Include any item or quantity of items, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide system documentation required herein.

PART 2 - PRODUCTS

2.1 CONTROL WIRING

- A. Provide control wiring large enough so voltage drop under in-rush conditions does not adversely affect operation of controls.
- B. Provide cable meeting specifications for type of cable.
- C. Outside Location (i.e. above ground, underground in conduit, ducts, pathways, etc.): Provide cables filled with a waterproofing compound between outside jacket (not touching any provided armor) and inter conductors to seal punctures in jacket and protect conductors from moisture.
- D. Remote Control Cable:
 - 1. Multi-conductor with stranded conductors able to handle power and voltage required to control specified system equipment, from a remote location.
 - 2. NRTL listed and pass VW-1 vertical wire flame test (UL 83) (formerly FR-1).

3. Color-coded Conductors: Combined multi-conductor and coaxial cables are acceptable for this installation, on condition system performance standards are met.
4. Technical Characteristics:
 - a. Length: As required, in 1K (3,000 ft.) reels minimum.
 - b. Connectors: As required by system design.
 - c. Size:
 - 1) 18 AWG, minimum, Outside.
 - 2) 20 AWG, minimum, Inside.
 - d. Color Coding: Required, EIA industry standard.
 - e. Bend Radius: 10 times cable outside diameter.
 - f. Impedance: As required.
 - g. Shield Coverage: As required by OEM specification.
 - h. Attenuation:

Frequency in MHz	dB per 305 Meter (1,000 feet), 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
50.0	52.0

- E. Distribution System Signal Wires and Cables:
 1. Provide in same manner, and use construction practices, as Fire Protective and other Emergency Systems identified and defined in NFPA 101, Life Safety Code, Chapters 7, 12, and 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions.
 2. Provide system able to withstand adverse environmental conditions without deterioration, in their respective location.

3. Provide entering of 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 cables.
4. Terminate on an item of equipment by direct connection.

2.2 COMMUNICATION AND SIGNAL WIRING

- A. Provide communications and signal wiring conforming to recommendations of manufacturers of systems ; provide not less than TIA Performance Category 6 .
- B. Wiring shown is for typical systems; provide wiring as required for systems being provided.
- C. Provide color-coded conductor insulation for multi-conductor cables.
- D. Connectors:
 1. Provide connectors for transmission lines, and signal extensions to maintain uninterrupted continuity, ensure effective connection, and preserve uniform polarity between all points in system.
 - a. Provide AC barrier strips with a protective cover to prevent accidental contact with wires carrying live AC current.
 - b. Provide punch blocks for signal connection, not AC power. AC power twist-on wire connectors are not permitted for signal wire terminations.
 2. Cables: Provide connectors designed for specific size cable and conductors being installed with OEM's approved installation tool. Typical system cable connectors include:
 - a. Audio spade lug.
 - b. Punch block.
 - c. Wirewrap.

2.3 INSTALLATION KIT

- A. Include connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, cable tray, etc., required to accomplish a neat and secure installation.
- B. Terminate conductors in a spade lug and barrier strip, wire wrap terminal or punch block, so there are no unfinished or unlabeled wire connections.

C. Minimum required installation sub-kits:

1. System Grounding:

a. Provide required cable and installation hardware for effective ground path, including the following:

- 1) Control Cable Shields.
- 2) Data Cable Shields.
- 3) Equipment Racks.
- 4) Equipment Cabinets.
- 5) Conduits.
- 6) Ducts.
- 7) Cable Trays.
- 8) Power Panels.
- 9) Connector Panels.
- 10) Grounding Blocks.

b. Bond radio equipment to earth ground via internal building wiring, according to NEC.

2. Wire and Cable: Provide connectors and terminals, punch blocks, tie wraps, hangers, clamps, labels, etc. required to accomplish termination in an orderly installation.

3. Conduit, Cable Duct, and Cable Tray: Provide conduit, duct, trays, junction boxes, back boxes, cover plates, feed through nipples, hangers, clamps, other hardware required to accomplish a neat and secure conduit, cable duct, cable tray installation in accordance with NEC and documents.

4. Equipment Interface: Provide any items or quantity of equipment, cable, mounting hardware and materials to interface systems with identified sub-systems, according to OEM requirements and construction documents.

5. Labels: Provide any item or quantity of labels, tools, stencils, and materials to label each subsystem according to OEM requirements, as-installed drawings, and construction documents.

D. Cross-Connection System (CCS) Equipment Breakout, Termination Connector (or Bulkhead), and Patch Panels:

1. Connector Panels: Flat smooth 3.175 mm (1/8 inch) thick solid aluminum, custom designed, fitted and installed in cabinet. Install bulkhead equipment connectors on panel to enable cabinet equipment's

signal, control, and coaxial cables to be connected through panel.
Match panel color to cabinet installed.

a. Voice (or Telephone):

- 1) Provide industry standard Type 110 (minimum) punch blocks for voice or telephone, and control wiring instead of patch panels, each being certified for category 5e or 6.
- 2) IDC punch blocks (with internal RJ45 jacks) are acceptable for use in CCS when designed for Category 5e or 6 and the size and type of cable used.
- 3) Secure punch block strips to OEM designed physical anchoring unit on a wall location in TRS; console, cabinet, rail, panel, etc. mounting is permitted at OEM recommendation and as accepted by COR. Punch blocks are not permitted for Class II or 120 VAC power wiring.
- 4) Technical Characteristics:
 - a) Number of Horizontal Rows: Minimum 100.
 - b) Number of Terminals per Row: Minimum 4.
 - c) Terminal Protector: Required for each used or unused terminal.
 - d) Insulation Splicing: Required between each row of terminals.

b. Digital or High-Speed Data:

- 1) Provide 480 mm (19 inches) horizontal EIA/ECA 310 rack mountable patch panel with EIA/ECA 310 standard spaced vertical mounting holes for digital or high-speed data service CSS, with modular female Category 5E (or on a case by case basis Category 6 or 6A for specialized powered systems accepted by SMCS 0050P2H3, (202) 461-5310, OI&T and FMS Services, and COR) RJ45 jacks designed for size and type of UTP or F/UTP cable installed in rows.
- 2) Technical Characteristics:
 - a) Number of Horizontal Rows: Minimum 2.
 - b) Number of Jacks Per Row: Minimum 24.
 - c) Type of Jacks: RJ45.
 - d) Terminal Protector: Required for each used or unused jack.
 - e) Insulation: Required between each row of jacks.

2.4 EXISTING WIRING

- A. Reuse existing wiring only where indicated on plans and accepted by SMCS 0050P2H3.
- B. Only existing wiring that conforms to specifications and applicable codes can be reused; existing wiring that does not meet these requirements cannot be reused and must be removed by contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install wiring in cable tray or raceway.
 - 2. Seal cable entering a building from underground, between wire and conduit where cable exits conduit, with non-hardening approved compound.
 - 3. Wire Pulling:
 - a. Provide installation equipment that prevents cutting or abrasion of insulation during pulling of cables.
 - b. Use ropes made of nonmetallic material for pulling feeders.
 - c. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached to conductors, as accepted by COR.
 - d. Pull multiple cables into a single conduit together.
- B. Installation in Maintenance or Manholes:
 - 1. Install and support cables in maintenance holes on steel racks with porcelain or equal insulators.
 - 2. Train cables around maintenance hole walls, but do not bend to a radius less than six times overall cable diameter.
- C. Control, Communication and Signal Wiring Installation:
 - 1. Unless otherwise specified in other sections, provide wiring and connect to equipment/devices to perform required functions as indicated.
 - 2. Install separate cables for each system so that malfunctions in any system does not affect other systems, except where otherwise required.
 - 3. Group wires and cables according to service (i.e. AC, grounds, signal, DC, control, etc.); DC, control and signal cables can be included with any group.

4. Form wires and cables to not change position in group throughout the conduit run. Bundle wires and cables in accepted signal duct, conduit, cable ducts, or cable trays neatly formed, tied off in 600 mm to 900 mm (24 inch to 36 inch) lengths to not change position in group throughout run.
5. Concealed splices are not allowed.
6. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure.
7. 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.
8. Provide ties and fasteners that do not damage or distort wires or cables. Limit spacing between tied points to maximum 150 mm (6 inches).
9. Install wires or cables outside of buildings in conduit, secured to solid building structures.
10. Wires or cables must be specifically accepted, on a case by case basis, to be installed outside of conduit. Bundled wires or cables must be tied at minimum 460 mm (18 inches) intervals to a solid building structure; bundled wires or cables must have ultraviolet protection and be waterproof (including all connections).
11. Laying wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not permitted.
12. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.:
 - a. Only when authorized, can wires or cables be identified and approved to be installed outside of conduit.
 - b. Provide wire or cable rated plenum and OEM certified for use in air plenums.
 - c. Provide wires and cables hidden, protected, fastened and tied at maximum 600 mm (24 inches) intervals, to building structure.
 - d. Provide closer wire or cable fastening intervals to prevent sagging, maintain clearance above suspended ceilings.

- e. Remove unsightly wiring and cabling from view and discourage tampering and vandalism.
 - f. Sleeve and seal wire or cable runs, not installed in conduit, that penetrate outside building walls, supporting walls, and two-hour fire barriers, with an approved fire-retardant sealant.
- D. AC Power:
- 1. Bond to ground contractor-installed equipment and identified Government-furnished equipment, to eliminate shock hazards and to minimize ground loops, common mode returns, noise pickup, crosstalk, etc. for total ground resistance of 0.1 Ohm or less.
 - 2. Use of conduit, signal duct or cable trays as system or electrical ground is not permitted; use these items only for dissipation of internally generated static charges (not to be confused with externally generated lightning) that can be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper system grounding is grounds to declare system unacceptable and termination of all system acceptance testing.
 - 3. Cabinet Bus: Extend a common ground bus of at least #10 AWG solid copper wire throughout each equipment cabinet and bond to system ground. Provide a separate isolated ground connection from each equipment cabinet ground bus to system ground. Do not tie equipment ground busses together.
 - 4. Equipment: Bond equipment to cabinet bus with copper braid equivalent to at least #12 AWG. Self-grounding equipment enclosures, racks or cabinets, that provide OEM certified functional ground connections through physical contact with installed equipment, are acceptable alternatives.

3.2 EQUIPMENT IDENTIFICATION

- A. Control, Communication and Signal System Identification:
- 1. Install a permanent wire marker on each wire at each termination.
 - 2. Identify cables with numbers and letters on the labels corresponding to those on wiring diagrams used for installing systems.
 - 3. Install labels retaining their markings after cleaning.
 - 4. In each maintenance hole (manhole) and handhole, install embossed brass tags to identify system served and function.

B. Labeling:

1. Industry Standard: ANSI/TIA-606-B.
2. Print lettering for voice and data circuits using laser printers or thermal ink transfer process
3. Cable and Wires (hereinafter referred to as "cable"): Label cables at both ends in accordance with industry standard. Provide permanent labels in contrasting colors. Identify cables matching system Record Wiring Diagrams.
4. Equipment: Permanently labeled system equipment with contrasting plastic laminate or bakelite material. Label system equipment on face of unit corresponding to its source.
5. Conduit, Cable Duct, and Cable Tray: Label conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying system. Label each enclosure according to this standard.
6. Termination Hardware: Label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with industry standard and Record Wiring Diagrams.

3.3 TESTING

- A. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on cables in frequency ranges specified.
- B. Tests required for data cable must be made to confirm operation of this cable at minimum 10 Mega (M) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of 10⁻⁶ at maximum rate of speed.
- C. Provide cable installation and test records at acceptance testing to COR and thereafter maintain in facility's telephone switch room.
- D. Record changes (used pair, failed pair, etc.) in these records as change occurs.
- E. Test cables after installation and replace any defective cables.

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SECTION 31 20 00
EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies the requirements for furnishing all equipment, materials, labor, tools, and techniques for earthwork including, but not limited to, the following:

1. Site preparation.
2. Excavation.
3. Underpinning
4. Filling and backfilling.
5. Grading.
6. Soil Disposal.
8. Rock-filled gabion
7. Clean Up.

1.2 DEFINITIONS:

A. Unsuitable Materials:

1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 75 mm (3 inches); organic material, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable and any material with a liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction, as defined by ASTM D698.
2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.2.A.1, that are not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proof-rolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from design requirements, excavate to acceptable strata subject to Contracting Officer's Representative's (COR) approval.

B. Building Earthwork: Earthwork operations required in area enclosed by a line located 1500 mm (5 feet) outside of principal building perimeter.

It also includes earthwork required for auxiliary structures and buildings.

- C. Trench Earthwork: Trenchwork required for utility lines.
- D. Site Earthwork: Earthwork operations required in area outside of a line located 1500 mm (5 feet) outside of principal building perimeter and within new construction area with exceptions noted above.
- E. Degree of compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. This percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1556, ASTM D2167, and ASTM D6938.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill as appropriate.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized additional excavation: Removal of additional material authorized by the COR based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over the excavated sub-grade in a trench before laying pipe. Bedding course shall extend up to the spring line of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals or products stored or found in containers or spilled on the ground.
- R. Contaminated soils: Soil that contains contaminants as defined and determined by the COR or the Government's testing agency.

1.3 RELATED WORK:

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Safety requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.
- C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.
- E. Erosion Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS, and Section 32 90 00, PLANTING.

1.4 CLASSIFICATION OF EXCAVATION:

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.

B. Rock Excavation:

1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be excavated with a late-model, track-mounted hydraulic excavator; equipped with a 1050 mm (42 inch) wide, short-tip-radius rock bucket; rated at not less than 103 kW (138 hp) flywheel power with bucket-curling force of not less than 125 kN (28,090 lbf) and stick-crowd force of not less than 84.5 kN (19,000 lbf); measured according to SAE J-1179. Trenches in excess of 3000 mm (10 feet) wide and pits in excess of 9000 mm (30 feet) in either length or width are classified as open excavation.
2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at not less than 157 kW (210 hp) flywheel power and developing a minimum of 216 kN (48,510 lbf) breakout force; measured according to SAE J-732.
3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 0.76 m³ (1 cubic yard) for open excavation, or 0.57 m³ (3/4 cubic yard) for footing and trench excavation that cannot be removed by rock excavating equipment equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.
4. Definitions of rock and guidelines for equipment are presented for general information purposes only. The Contractor is expected to use the information presented in the Geotechnical Engineering Report to evaluate the extent and competency of the rock and to determine both quantity estimations and removal equipment and efforts.

1.5 MEASUREMENT AND PAYMENT FOR EXCAVATION:

- A. Measurement: The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes,

when the material is acceptably utilized or disposed of as herein specified. Quantities should be computed by a Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. The measurement will include authorized excavation for rock, authorized excavation of satisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow pits, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to taking of elevations and measurements of the undisturbed grade.

1.6 MEASUREMENT AND PAYMENT FOR ROCK EXCAVATION:

- A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS. Do not measure quantities beyond the following limits:
1. 600 mm (24 inches) from outside face of concrete work for which forms are required, except for footings.
 2. 300 mm (12 inches) from outside of perimeter of formed footings.
 3. 150 mm (6 inches) below bottom of pipe and not more than pipe diameter plus 600 mm (24 inches) in width for pipe trenches.
 4. From outside dimensions of concrete work for which no forms are required (trenches, conduits, and similar items not requiring forms).
- B. Payment: No separate payment shall be made for rock excavation quantities shown. Contract price and time will be adjusted for overruns or underruns in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
- C. Payment for Differing Site Conditions: When rock excavation, as classified, is encountered, contract price and time will be adjusted in

accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.

1.7 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Rock Excavation Report:
 - 1. Certification of rock quantities excavated.
 - 2. Excavation method.
 - 3. Labor.
 - 4. Equipment.
 - 5. Land Surveyor's or Civil Engineer's name and official registration stamp.
 - 6. Plot plan showing elevation.
- C. Furnish to COR:
 - 1. Contactor shall furnish resumes with all personnel involved in the project including Project Manager, Superintendent, and on-site Engineer. Project Manager and Superintendent should have at least 3 years of experience on projects of similar size.
 - 2. Soil samples.
 - a. Classification in accordance with ASTM D2487 for each on-site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - b. Laboratory compaction curve in accordance with ASTM D698 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
 - c. Test reports for compliance with ASTM D2940 requirements for subbase material.
 - d. Pre-excavation photographs and videotape in the vicinity of the existing structures to document existing site features, including surfaces finishes, cracks, or other structural blemishes that might be misconstrued as damage caused by earthwork operations.
 - e. The Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.
 - 3. Contractor shall submit procedure and location for disposal of unused satisfactory material. Proposed source of borrow material.

Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.8 APPLICABLE PUBLICATIONS:

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

B. American Association of State Highway and Transportation Officials (AASHTO):

T99-10Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop

T180-10Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb) Rammer and a 457 mm (18 inch) Drop

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

C33-03Concrete Aggregate

D448-08Standard Classification for Sizes of Aggregate for Road and Bridge Construction

D698-07e1Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft³ (600 kN m/m³))

D1140-00Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

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

D1557-09Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN m/m³))

D2167-08Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

D2487-11Standard Classification of Soils for
Engineering Purposes (Unified Soil
Classification System)

D. Society of Automotive Engineers (SAE):

J732-07Specification Definitions - Loaders

J1179-08Hydraulic Excavator and Backhoe Digging Forces

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Fills: Material in compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups; free of rock or gravel larger than 75mm (3 inches) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Material approved from on site or off site sources having a minimum dry density of 1760 kg/m³ (110 pcf), a maximum Plasticity Index of 15, and a maximum Liquid Limit of 40.
- C. Engineered Fill: Naturally or artificially graded mixture of compliance with ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, and ML, or any combination of these groups, or as approved by the Engineer or material with at least 90 percent passing a 37.5-mm (1 1/2-inch) sieve and not more than 12 percent passing a 75- μ m (No. 200) sieve, per ASTM D2940;.
- D. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 25 mm (1 inch) sieve and not more than 8 percent passing a 75- μ m (No. 200) sieve.
- E. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 37.5 mm (1 1/2-inch) sieve and 0 to 5 percent passing a 2.36 mm (No. 8) sieve.
- F. Granular Fill:
 - 1. Under concrete slab, - granular fill shall consist of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off

the capillary flow of pore water to the area immediately below.

Fine aggregate grading shall conform to ASTM C 33 with a maximum of 3 percent by weight passing ASTM D 1140, 75 micrometers (No. 200) sieve, and no more than 2 percent by weight passing the coarse aggregate Size 57, 67, or 77.

2. Bedding for sanitary and storm sewer pipe, crushed stone or gravel graded from 13 mm (1/2 inch) to 4.75 mm (No 4), per ASTM D2940.

G. Requirements for Offsite Soils: Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCLP test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA SW-846.3-3a Method 5030/8020. TCLP shall be performed in accordance with EPA SW-846.3-3a Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site.

H. Buried Warning and Identification Tape: Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as specific below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, Unaffected by moisture or soil. Warning tape color codes:

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems

Gray: Compressed Air

- I. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.076 mm (0.003 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise, and 8.6 MPa (1250 psi) crosswise, with a maximum 350 percent elongation.
- J. Detectable Warning Tape for Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.102 mm (0.004 inch). Tape shall have a minimum strength of 10.3 MPa (1500 psi) lengthwise and 8.6 MPa (1250 psi) crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 0.9 m (3 feet) deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.
- K. Detection Wire for Non-Metallic Piping: Detection wire shall be Insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 - EXECUTION

3.1 SITE PREPARATION:

- A. Clearing: Clear within limits of earthwork operations as shown. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions. Remove materials from Medical Center.
- B. Grubbing: Remove stumps and roots 75 mm (3 inch) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inch) diameter, and nonperishable solid objects a minimum of 900 mm (3 feet) below subgrade or finished embankment may be left.
- C. Trees and Shrubs: Trees and shrubs, not shown for removal, may be removed from areas within 4500 mm (15 feet) of new construction and 2250 mm (7.5 feet) of utility lines when removal is approved in advance by COR. Remove materials from Medical Center. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in construction area. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas,

including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs, that are to remain, than farthest extension of their limbs.

- D. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by COR. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m³ (1/2 cubic foot) in volume, from soil as it is stockpiled. Retain topsoil on station. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil used in final grading. Topsoil work, such as stripping, stockpiling, and similar topsoil work shall not, under any circumstances, be carried out when soil is wet so that the composition of the soil will be destroyed.
- E. Concrete Slabs and Paving: Score deeply or saw cut to insure a neat, straight cut, sections of existing concrete slabs and paving to be removed where excavation or trenching occurs. Extend pavement section to be removed a minimum of 300 mm (12 inches) on each side of widest part of trench excavation and insure final score lines are approximately parallel unless otherwise indicated. Remove material from Medical Center.
- F. Lines and Grades: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and grades.
1. Grades shall conform to elevations indicated on plans within the tolerances herein specified. Generally grades shall be established to provide a smooth surface, free from irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate

transition at structures and paving and uninterrupted drainage flow into inlets.

2. Locations of existing and proposed elevations indicated on plans, except spot elevations are approximate. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Contractor is responsible to notify COR of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify COR of any differences between existing or constructed grades, as compared to those shown on the plans.
3. Subsequent to establishment of lines and grades, Contractor will be responsible for any additional cut and/or fill required to ensure that site is graded to conform to elevations indicated on plans.
4. Finish grading is specified in Section 32 90 00, PLANTING.

G. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations.

3.2 EXCAVATION:

A. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the COR, banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities.

1. Design of the temporary support of excavation system is the responsibility of the Contractor. The Contractor shall submit a Shoring and Sheet piling plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheet piling of excavations. Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheet piling shall be removed as excavations are backfilled, in a manner to prevent caving.

2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the COR.
 3. Extend shoring and bracing to a minimum of 1500 mm (5 feet) below the bottom of excavation. Shore excavations that are carried below elevations of adjacent existing foundations.
 4. If bearing material of any foundation is disturbed by excavating, improper shoring or removal of existing or temporary shoring, placing of backfill, and similar operations, the Contractor shall underpin the existing foundation, per Section 3.3 under disturbed foundations, as directed by COR, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by COR.
 5. The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer shall be responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer shall update the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and shall submit an updated plan if necessary. A written report shall be submitted, at least monthly, informing the Contractor and COR of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Geotechnical Engineer shall be available to meet with the COR at any time throughout the contract duration.
- B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required to keep excavation free of water and subgrade dry, firm, and undisturbed until approval of permanent work has been received from COR. Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 0.9 m (3 feet) of the foundation of any structure, except with specific

written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously below the working level.

- C. Subgrade Protection: Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation. Reroute surface water runoff from excavated areas and not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. When subgrade for foundations has been disturbed by water, remove disturbed material to firm undisturbed material after water is brought under control. Replace disturbed subgrade in trenches with concrete or material approved by the COR.
- D. Proofrolling:
1. After rough grade has been established in cut areas and prior to placement of fill in fill areas under building and pavements, proofroll exposed subgrade with a fully loaded dump truck to check for pockets of soft material.
 2. Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. When proof rolling, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the VHA COR a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the COR. Rutting or pumping of material shall be undercut as directed by the VHA COR and replaced with fill and backfill material. Maintain subgrade until succeeding operation has been accomplished.
- E. Building Earthwork:
1. Excavation shall be accomplished as required by drawings and specifications.
 2. Excavate foundation excavations to solid undisturbed subgrade.
 3. Remove loose or soft materials to a solid bottom.

4. Fill excess cut under footings or foundations with 25 MPa (3000 psi) concrete poured separately from the footings.
5. Do not tamp earth for backfilling in footing bottoms, except as specified.
6. Slope grades to direct water away from excavations and to prevent ponding.
7. Capillary water barrier (granular fill) under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.
8. Ensure that footing subgrades have been inspected and approved by the COR prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the COR. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

F. Trench Earthwork:

1. Utility trenches (except sanitary and storm sewer):
 - a. Excavate to a width as necessary for sheeting and bracing and proper performance of the work.
 - b. Grade bottom of trenches with bell holes scooped out to provide a uniform bearing.
 - c. Support piping on suitable undisturbed earth unless a mechanical support is shown. Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm (6 inches) loose thickness.
 - d. Length of open trench in advance of piping laying shall not be greater than is authorized by COR.
 - e. Provide buried utility lines with utility identification tape. Bury tape 300 mm (12 inches) below finished grade; under pavements and slabs, bury tape 150 mm (6 inches) below top of subgrade
 - f. Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm (12 inches) above the top of pipe.

The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 0.9 m (3 feet) of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

- g. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:
- 1) Class I: Angular, 6 to 40 mm (0.25 to 1.5 inches), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.
 - 2) Class II: Coarse sands and gravels with maximum particle size of 40 mm (1.5 inches), including various graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

2. Sanitary and storm sewer trenches: - NOT USED

- G. Site Earthwork: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

Excavation shall be accomplished as required by drawings and specifications. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 25 mm (1 inch). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, complying with OSHA requirements, and for inspections. Remove subgrade materials that are determined by COR as unsuitable, and replace with acceptable material. When unsuitable material is encountered and removed, contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable. Adjustments to be based on volume in cut section only.

1. Site Grading:

- a. Provide a smooth transition between adjacent existing grades and new grades.
- b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- c. Slope grades to direct water away from buildings and to prevent ponds from forming where not designed. Finish subgrades to required elevations within the following tolerances:
 - 1) Lawn or Unpaved Areas: Plus or minus 25 mm (1 inch).
 - 2) Walks: Plus or minus 6 mm (1/4 inch).
 - 3) Pavements: Plus or minus 13 mm (1/2 inch).
- d. Grading Inside Building Lines: Finish subgrade to a tolerance of 13 mm (1/2 inch) when tested with a 3000 mm (10 foot) straightedge.

3.3 UNDERPINNING: - NOT USED

3.4 FILLING AND BACKFILLING:

- A. General: Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation. For fill and backfill, use excavated materials and borrow meeting the criteria specified herein, as applicable. Borrow will be supplied at no additional cost to the Government. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately

braced, waterproofing or dampproofing applied, foundation drainage, and pipes coming in contact with backfill have been installed and work inspected and approved by COR.

- B. Placing: Place materials in horizontal layers not exceeding 200 mm (8 inches) in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4 inches) in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure. Place no material on surfaces that are muddy, frozen, or contain frost.
- C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other approved equipment (hand or mechanized) well suited to soil being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without prior approval of COR. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Compact soil to not less than the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:
 - 1. Fills, Embankments, and Backfill
 - a. Under proposed structures, building slabs, steps, and paved areas, scarify and recompact top 300 mm (12 inches) of existing subgrade and each layer of backfill or fill material in accordance with ASTM D698 95 percent.
 - b. Curbs, curbs and gutters, ASTM D698 95 percent.
 - c. Under Sidewalks, scarify and recompact top 150 mm (6 inches) below subgrade and compact each layer of backfill or fill material in accordance with ASTM D698 95 percent.
 - d. Landscaped areas, top 400 mm (16 inches), ASTM D698 85 percent.

- e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D698 90 percent.
- 2. Natural Ground (Cut or Existing)
 - a. Under building slabs, steps and paved areas, top 150 mm (6 inches), ASTM D698 95 percent.
 - b. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D698 95 percent.
 - c. Under sidewalks, top 150 mm (6 inches), ASTM D698 95 percent.
- D. Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas from approved private sources. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.
- E. Opening and Drainage of Excavation and Borrow Pits: The Contractor shall notify the COR sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 GRADING:

- A. General: Uniformly grade the areas within the limits of this section, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between such points and existing finished grades. Provide a smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls for a minimum distance of 1800 mm (6 feet).
- D. Finish grade earth floors in pipe basements as shown to a level, uniform slope and leave clean.
- E. Finished grade shall be at least 150 mm (6 inches) below bottom line of window or other building wall openings unless greater depth is shown.
- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped, and leveled. Thickness of fill shall be 150 mm (6 inches) unless otherwise shown.
- G. Finish subgrade in a condition acceptable to COR at least one day in advance of paving operations. Maintain finished subgrade in a smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade prior to further construction when approved compacted subgrade is disturbed by Contractor's subsequent operations or adverse weather.
- H. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- B. Stockpile, spread or dispose of satisfactory soil as directed by COR.
 - 1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.

- C. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- D. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.
- E. Segregate all excavated contaminated soil designated by the COR from all other excavated soils, and stockpile on site on two 0.15 mm (6 mil) polyethylene sheets with a polyethylene cover. A designated area shall be selected for this purpose. Dispose of excavated contaminated material in accordance with State and Local requirements.

3.7 WIRE-ENCLOSED GABIONS (ADOPTED FROM WYOMING DOT) :

- A. Lace adjacent gabions (new-to-new and new-to-existing) along the perimeter of contact surfaces. Wire the bases of empty gabions placed on top of filled gabions tightly to the filled gabions. Stagger joints between ends of adjacent gabion baskets in a row at least 18 in [450 mm] from those in the row below.
- B. Stretch the gabions in accordance with the manufacturer's recommendations to provide proper alignment. While stretching, inspect corners for open Vs; if found, close Vs by replacing the material. Ensure that the stretching provides a resistant force to prevent bulging while installing the aggregate fill and connecting wires.
- C. Place the last layer of stone in a gabion level with the top of the gabion to provide an even surface for the next course of gabions. Before placing the next course, backfill the completed course with site-excavated material in accordance with Specification 31 20 00 Earthwork, Backfilling, and without displacing or damaging gabions.
- D. For enclosing riprap, provide and use 2 in × 4 in [50 mm × 100 mm], V-mesh woven-wire fabric with double strand 122-gage [2.51 mm] horizontal wires and 122-gage [2.51 mm], single-strand cross wires. Provide wire in accordance with ASTM A 116, class 1 or better.
- E. Provide and use a woven wire fabric in accordance with ASTM A 975, style 1.
- F. Provide galvanized, 122-gage [2.51 mm], smooth steel lacing and tie wire; galvanized 9-gage [3.76 mm] hog rings at 4-inch [100 mm] spacing

may be used to fasten ends, sides, and top panels.

G. For steel stakes, provide 5-foot [1.5 m] crane rails, nominal 3-inch [75 mm] standard pipe, or angles 4 in × 4 in × in [100 mm × 100 mm × 10 mm]. Rail, pipe, or angles free from rust or damage that could affect the stake's strength may be reused.

H. Provide and use round or angular stones of which:

1. At least of 95 percent are retained on a screen with 4-inch [100 mm] square openings;
2. No more than 5 percent are retained on a screen with 62-inch [152.5 mm] square openings; and
3. 100 percent pass through a screen with 8-inch [200 mm] square openings.

3.8 CLEAN UP:

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Medical Center.

----- E N D -----

**SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Subbase for concrete pavements.
2. Equipment Pads: Propane tanks, Pump station.

1.2 RELATED REQUIREMENTS

- A. Subgrade Preparation and Subbase Compaction: Section 31 20 00, EARTHWORK.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Association of State Highway and Transportation Officials (AASHTO):
1. M147-65-UL-04 - Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses..
 2. M233-86 - Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
- C. American Concrete Institute (ACI):
1. 305R-10 - Guide to Hot Weather Concreting.
 2. 306R-10 - Guide to Cold Weather Concreting.
- D. American National Standards Institute (ANSI):
1. B101.3 - Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).
- E. ASTM International (ASTM):
1. A615/A615M-16 - Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
 2. A996/A996M-15 - Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
 3. A1064/A1064M-16 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 4. C33/C33M-16 - Concrete Aggregates.
 5. C94/C94M-16 - Ready Mixed Concrete.
 6. C143/C143M-15a - Slump of Hydraulic Cement Concrete.

7. C150/C150M-16 - Portland Cement.
8. C171-16 - Sheet Materials for Curing Concrete.
9. C260/C260M-10a - Air Entraining Admixtures for Concrete.
10. C309-11 - Liquid Membrane Forming Compounds for Curing Concrete.
11. C494/C494M-15a - Chemical Admixtures for Concrete.
12. C618-15 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
13. C979/C979M-16 - Pigments for Integrally Colored Concrete.
14. C989/C989M-14 - Slag Cement for Use in Concrete and Mortars.
15. C1240-15 - Silica Fume Used in Cementitious Mixtures.
16. D1751-04(2013)e1 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
17. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
18. D6690-15 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
 1. Required Participants:
 - a. Contracting Officer's Representative.
 - b. Engineer.
 - c. Testing Agency.
 - d. Contractor.
 - e. Installer.
 - f. Others, as requested by the Contracting Officer Representative (COR)
 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Installation schedule.
 - b. Installation sequence.
 - c. Preparatory work.
 - d. Protection before, during, and after installation.
 - e. Installation.
 - f. Terminations.

- g. Transitions and connections to other work.
 - h. Inspecting and testing.
 - i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
 - 1. Show size, configuration, and fabrication and installation details.
 - 2. Show reinforcing.
 - 3. Include jointing plan for concrete pavements, curbs and gutters.
- C. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Installation instructions.
- D. Samples, as requested by the COR.
- E. Test reports: Certify products comply with specifications.
 - 1. Concrete materials.
 - 2. Select subbase materials.
 - 3. Field test reports.
- F. Certificates: Certify products comply with specifications.
 - 1. Expansion joint filler.
 - 2. Reinforcement.
 - 3. Curing materials.
 - 4. Concrete protective coating.
- G. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Installer.
 - 2. Land surveyor.
- H. Concrete mix design.
- I. Select subbase job-mix design.
- J. Proposed hot and cold weather concreting methods.
- K. Land surveyor's construction staking notes, before placing concrete.
 - 1. Identify discrepancies between field conditions and Drawings.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Regularly installs specified products.

2. Installed specified products with satisfactory service on five similar installations.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Land Surveyor: Professional land surveyor or engineer registered to provide land surveys in jurisdiction where project is located.
- C. Preconstruction Testing:
 1. Engage independent testing laboratory to perform tests and submit reports.
 - a. Deliver samples to laboratory in number and quantity required for testing.
 2. Concrete mix design.
 3. Select subbase job-mix design. Report the following:
 - a. Material sources.
 - b. Gradation.
 - c. Plasticity index.
 - d. Liquid limit.
 - e. Laboratory compaction curves indicating maximum density at optimum moisture content.

1.7 DELIVERY

- A. Deliver steel reinforcement to prevent damage.
- B. Before installation, return or dispose of distorted or damaged steel reinforcement.
- C. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

1.8 STORAGE AND HANDLING

- A. Store products indoors in dry, weathertight facility.
- B. Protect products from damage during handling and construction operations.

1.9 FIELD CONDITIONS

- A. Hot Weather Concreting Procedures: ACI 305R.
- B. Cold Weather Concreting Procedures: ACI 306R.
 1. Use non-corrosive, non-chloride accelerator admixture.

2. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions.

1.10 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II.
- B. Pozzolans:
1. Fly Ash: ASTM C618, Class C or F including supplementary optional physical requirements.
 2. Slag: ASTM C989/C989M; as proposed and approved by mix design.
 3. Silica Fume: ASTM C1240.
- C. Coarse Aggregate: ASTM C33/C33M; size $\frac{3}{4}$ " minus or Grade C AASHTO.
- D. Fine Aggregate: ASTM C33/C33M.
- E. Mixing Water: Fresh, clean, and potable.
- F. Air-Entraining Admixture: ASTM C260/C260M.
- G. Chemical Admixtures: ASTM C494/C494M.
- H. Reinforcing Steel: ASTM A615/A615M or ASTM A996/A996M, Grade 280 (40).
- I. Welded Wire Fabric: ASTM A1064/A1064M, plain; Grade 385 (56); sized as indicated.
- J. Expansion Joint Filler: ASTM D1751.
- K. Sheet Materials for Curing Concrete: ASTM C171.

2.2 SELECT SUBBASE

- A. Subbase: AASHTO M147; Grade C .
1. Select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials.

SUBBASE GRADING REQUIREMENTS							
Sieve Size		Percentage Passing by Mass					
		Grades					
(mm)	(in)	A	B	C	D	E	F
50	2	100	100				

SUBBASE GRADING REQUIREMENTS							
Sieve Size		Percentage Passing by Mass					
25	1		75-95	100	100	100	100
9.5	3/8	30-65	40-75	50-85	60-100		
4.47	No. 4	25-55	30-60	35-65	50-85	55-100	70-100
2.00	No. 10	15-40	20-45	25-50	40-70	40-100	55-100
0.425	No. 40	8-20	15-30	15-30	25-45	20-50	30-70
0.075	No. 200	2-8	5-20	5-15	5-20	6-20	8-25

B. Other Acceptable Gradations: Materials within three to five percent, plus or minus, of specified gradation, or as recommended by the geotechnical engineer and approved by the Contracting Officer's Representative.

2.3 FORMS

- A. Forms: Wood, plywood, metal, or other materials, approved by Contracting Officer's Representative, of grade or type suitable to obtain type of finish specified.
1. Plywood: Exterior grade, free of defects and patches on contact surface.
 2. Lumber: Sound, grade-marked, S4S stress graded softwood, minimum 50 mm (2 inches) thick, free from warp, twist, loose knots, splits, or other defects.
 3. Form Coating: As recommended by Architect/Engineer.
- B. Provide forms suitable in cross-section, depth, and strength to resist springing during depositing and consolidating concrete.
1. Do not use forms varying from straight line more than 3 mm in 3000 mm (1/8 inch in 10 feet), horizontally and vertically.
- C. Provide flexible or curved forms for forming radii.

2.4 CONCRETE CURING MATERIALS

- A. Concrete curing materials, conform to one of the following:
1. Burlap: Minimum 233 g/sq. m (7 ounces/sq. yd.) dry.
 2. Sheet Materials for Curing Concrete: ASTM C171.
 3. Curing Compound: ASTM C309, Type 1-D; liquid membrane forming type, without paraffin or petroleum.

2.5 CONCRETE MIXES

- A. Design concrete mixes according to ASTM C94/C94M, Option C.
 B. Concrete Type: Air-entrained. See Table I.

TABLE I - CONCRETE TYPES					
Concrete Type	Minimum 28 Day Compressive Strength f'c MPa (psi)	Non-Air-Entrained		Air-Entrained	
		Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio	Min. Cement kg/cu. m (lbs./cu. yd.)	Max. Water Cement Ratio
A	35 (5000)1,3	375 (630)	0.45	385 (650)	0.40
B	30 (4000)1,3	325 (550)	0.55	340 (570)	0.50
C	25 (3000)1,3	280 (470)	0.65	290 (490)	0.55
D	25 (3000)1,2	300 (500)	*	310 (520)	*

Footnotes:

1. If trial mixes are used, achieve compressive strength 8.3 MPa (1,200 psi) in excess of f'c. For concrete strengths greater than 35 MPa (5,000 psi), achieve compressive strength 9.7 MPa (1,400 psi) in excess of f'c.
2. For Concrete Exposed to High Sulfate Content Soils: Maximum water cement ratio is 0.44.
3. Laboratory Determined according to ACI 211.1 for normal weight concrete.

- C. Maximum Slump: ASTM C143/C143M. See Table II.

TABLE II - MAXIMUM SLUMP	
APPLICATION	MAXIMUM SLUMP
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)
Vehicular Pavement	50 mm (2 inches) Machine Finished 100 mm (4 inches) Hand Finished
Equipment Pad	75 to 100 mm (3 to 4 inches)

2.6 ACCESSORIES

- A. Equipment and Tools: Obtain Contracting Officer's Representative's, approval of equipment and tools needed for handling materials and performing work before work begins.
 B. Maintain equipment and tools in satisfactory working condition.

- C. Sealants:
 - 1. Concrete Paving Expansion Joints: ASTM D5893/D5893M, Type SL, single component, self-leveling, silicone joint sealant.
 - 2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.
- D. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Prepare, construct, and finish subgrade. See Section 31 20 00, EARTHWORK.
- D. Maintain subgrade in smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE

- A. Placing:
 - 1. Place subbase material on prepared subgrade in uniform layer to required contour and grades, and to maximum 200 mm (8 inches) loose depth.
 - 2. When required compacted thickness exceeds 150 mm (6 inches), place subbase material in equal thickness layers.
 - 3. When subbase elevation is 13 mm (1/2 inch) or more below required grade, excavate subbase minimum 75 mm (3 inches) deep. Place and compact subbase to required grade.
- B. Compaction:
 - 1. Perform compaction with approved hand or mechanical equipment well suited to the material being compacted.
 - 2. Maintain subbase at optimum moisture content for compaction.
 - 3. Compact each subbase layer to minimum 95 percent or 100 percent of maximum density as specified in Section 31 20 00, EARTHWORK.
- C. Subbase Tolerances:
 - 1. Variation from Indicated Grade: Maximum 9 mm (3/8 inch).
 - 2. Variation from Indicated Thickness: Maximum 13 mm (1/2 inch).
- D. Protection:

1. Protect subbase from damage until concrete is placed.
2. Reconstruct damaged subbase before placing concrete.

3.3 SETTING FORMS

A. Form Substrate:

1. Compact form substrate to uniformly support forms along entire length.
2. Correct substrate imperfections and variations by cutting, filling, and compacting.

B. Form Setting:

1. Set forms to indicated line and grade with tight joints. Rigidly brace forms preventing movement.
2. Remove forms when removal will not damage concrete and when required for finishing.
3. Clean and oil forms before each use.
4. Correct forms, when required, immediately before placing concrete.

C. Land Surveyor: Establish control, alignment, and grade for forms.

1. Notify Contracting Officer's Representative immediately when discrepancies exist between field conditions and drawings.
2. Correct discrepancies greater than 25 mm (1 inch) before placing concrete.

D. Form Tolerances:

1. Variation from Indicated Line: Maximum 6 mm (1/4 inch).
2. Variation from Indicated Grade: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).

3.4 PLACING REINFORCEMENT

- A. Keep reinforcement clean from contamination preventing concrete bond.
- B. Install reinforcement shown on drawings.
- C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.
- D. Obtain Contracting Officer's Representative's reinforcement placement approval before placing concrete.

3.5 JOINTS - GENERAL

- A. Place joints, where shown on approved submittal Drawings.
 1. Conform to details shown.
 2. Install joints perpendicular to finished concrete surface.

- B. Make joints straight and continuous from edge to edge of pavement.

3.6 CONSTRUCTION JOINTS

- A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown on approved submittal Drawings.
- B. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.

3.7 CONTRACTION JOINTS

- A. Tool or cut joints to width, depth, and radius edge shown on drawings using grooving tool, jointer, or saw.
- B. Construct joints in curbs and gutters by inserting 3 mm (1/8 inch) steel plates conforming to curb and gutter cross sections.
 - 1. Keep plates in place until concrete can hold its shape.
- C. Finish joint edges with edging tool.
- D. Score pedestrian pavement with grooving tool or jointer.

3.8 EXPANSION JOINTS

- A. Form expansion joints with expansion joint filler of thickness shown on drawings.
 - 1. Locate joints around perimeter of structures and features abutting site work concrete.
 - 2. Create complete, uniform separation between structure and site work concrete.
- B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on Drawings.
- C. Cut and shape material matching cross section.
- D. Anchor with approved devices to prevent displacing during placing and finishing operations.
- E. Round joint edges with edging tool.

3.9 PLACING CONCRETE - GENERAL

- A. Preparation before Placing Concrete:
 - 1. Obtain Contracting Officer's Representative approval.
 - 2. Remove debris and other foreign material.
 - 3. Uniformly moisten substrate, without standing water.
- B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.

- C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.
 - 1. Vibrate concrete against forms and along joints.
 - 2. Avoid excess vibration and handling causing segregation.
- D. Place concrete continuously between joints without bulkheads.
- E. Install construction joint in concrete placement suspended for more than 30 minutes.
- F. Replace concrete with cracks, chips, bird baths, and other defects to nearest joints, approved by Contracting Officer's Representative.

3.10 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS

- A. Place concrete in one layer conforming to cross section shown on Drawings after consolidating and finishing.
- B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.
- C. Strike concrete surface to proper section ready for consolidation.
- D. Consolidate concrete by tamping and spading.
- E. Finish concrete surface with wood or metal float.
- F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

3.11 PLACING CONCRETE FOR VEHICULAR PAVEMENT - NOT USED

3.12 FORM REMOVAL

- A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.
- B. Do not use bars or heavy tools against concrete to remove forms. Repair damage concrete found after form removal.

3.13 CONCRETE FINISHING - GENERAL

- A. Follow operation sequence below, unless otherwise indicated on Drawings:
 - 1. Consolidating, floating, striking, troweling, texturing, and joint edging.
- B. Use edging tool with 6 mm (1/4 inch) radius, unless otherwise shown on Drawings.
- C. Keep finishing equipment and tools clean and suitable for use.

3.14 CONCRETE FINISHING - PEDESTRIAN PAVEMENT - NOT USED**3.15 CONCRETE FINISHING - VEHICULAR PAVEMENT - NOT USED****3.16 CONCRETE FINISHING - CURBS AND GUTTERS - NOT USED****3.17 CONCRETE FINISHING - EQUIPMENT PADS**

- A. Strike pad surface to elevation shown on Drawings.
- B. Provide smooth, dense float finish, free from depressions or irregularities.
- C. Finish pad edges with edger.
- D. After removing forms, rub pad edge faces with wood or concrete rubbing block, removing blemishes, form marks, and tool marks and providing uniform color.
- E. Pad Tolerances:
 - 1. Variation from Indicated Plane: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
 - 2. Variation from Indicated Elevation: Maximum 6 mm (1/4 inch).
 - 3. Variation from Indicated Thickness: Maximum 6 mm (1/4 inch).
- F. Replace pads when pads exceed specified tolerances.

3.18 SPECIAL FINISHES - NOT USED**3.19 CONCRETE CURING**

- A. Concrete Protection:
 - 1. Protect unhardened concrete from rain and flowing water.
 - 2. Provide sufficient curing and protection materials available and ready for use before concrete placement begins.
 - 3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
 - a. Replace pavement damaged by curing method allowing concrete cracking.
 - b. Employ another curing method as directed by Contracting Officer's Representative.
- B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
 - 1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap Mats at least 150 mm (6 inches).
 - 2. Sheet Materials:

- a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
 - b. Overlap sheets minimum 300 mm (12 inches).
 - c. Securely anchor sheet materials preventing displacement.
3. Curing Compound:
- a. Protect joints indicated to receive sealants preventing contamination from curing compound.
 - b. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
 - c. Apply curing compound before concrete dries.
 - d. Apply curing compound in two coats at right angles to each other.
 - e. Application Rate: Maximum 5 sq. m/L (200 sq. ft./gallon), both coats.
 - f. Immediately reapply curing compound to surfaces damaged during curing period.

3.20 CONCRETE PROTECTIVE COATING

- A. Apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against concrete exterior improvements to protect the concrete against deicing materials.
- B. Complete backfilling and curing operation before applying protective coating.
- C. Dry and thoroughly clean concrete before each application.
- D. Apply two coats, with maximum coverage of 11 sq. m/L (50 sq. yds./gal.); first coat, and maximum 16 sq. m/L (70 sq. yds./gal.); second coat, except apply commercially prepared mixture according to manufacturer's instructions.
- E. Protect coated surfaces from vehicular and pedestrian traffic until dry.
- F. Do not heat protective coating, and do not expose protective coating to open flame, sparks, or fire adjacent to open containers or applicators. Do not apply material at temperatures lower than 10 degrees C (50 degrees F).

3.21 FIELD QUALITY CONTROL

- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
 - 1. Compaction.
 - a. Pavement subgrade.
 - b. Curb, gutter, and sidewalk.
 - 2. Concrete:
 - a. Delivery samples.
 - b. Field samples.
 - 3. Slip Resistance: Steps and pedestrian paving.

3.22 CLEANING

- A. After completing curing:
 - 1. Remove burlap and sheet curing materials.
 - 2. Sweep concrete clean, removing foreign matter from the joints.
 - 3. Seal joints as specified.

3.23 PROTECTION

- A. Protect exterior improvements from traffic and construction operations.
 - 1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by Contracting Officer's Representative.
- B. Remove protective materials immediately before acceptance.
- C. Repair damage.
 - 1. Replace concrete containing excessive cracking, fractures, spalling, and other defects within joint boundary, when directed by Contracting Officer's Representative, and at no additional cost to the Government.

- - - E N D - - -

**SECTION 32 90 00
PLANTING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Seed, soils, and landscape materials.

1.2 RELATED REQUIREMENTS

1.3 DEFINITIONS

- A. Pesticide: Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and is specifically labeled for use by U.S. Environmental Protection Agency (EPA). Also, any substance used as plant regulator, defoliant, disinfectant, or biocide.

1.4 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute (ANSI):
1. Z60.1-2014 - Nursery Stock.
- C. American Society for Testing And Materials (ASTM):
1. C33/C33M-16-Concrete Aggregates.
 2. C136/C136M-14 - Sieve Analysis of Fine and Coarse Aggregates.
 3. C602-13a - Agricultural Liming Materials.
 4. .
 5. D5268-13 - Topsoil Used for Landscaping Purposes.
- D. Hortus Third: Concise Dictionary of Plants Cultivated in United States and Canada.
- E. United States Department of Agriculture (USDA):
1. DOA SSIR 42-2014 - Soil Survey Laboratory Methods Manual.
 2. Handbook No. 60 - Diagnosis and Improvement of Saline and Alkali Soils.

1.5 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
1. Required Participants:
 - a. Contracting Officer's Representative.
 - b. Contractor.

- c. Installer.
- 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Inspection of planting materials.
 - b. Installation schedule.
 - c. Installation sequence.
 - d. Preparatory work.
 - e. Protection before, during, and after installation.
 - f. Installation.
 - g. Inspecting.
 - h. Environmental procedures.
- 3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.6 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Installation instructions.
 - 3. Warranty.
- C. Samples:
- D. Sustainable Construction Submittals:
 - 1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
 - 2. Biobased Content:
 - a. Show type and quantity for each product.
- E. Test reports: Certify products comply with specifications.
- F. Certificates: Certify products comply with specifications.
 - 1. Seed Materials: Notarized certificate of product analysis.
- G. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Installer, including supervisor with project experience list.
- H. Operation and Maintenance Data:
 - 1. Care instructions for each plant material.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Regularly installs specified products.

2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
3. Member in good standing of either Professional Landcare Network or American Nursery and Landscape Association.
4. Personnel assigned to Work certified in all of the following categories from National Association of Landscape Professionals and submit one copy of certificate to Contracting Officer's Representative:
 - a. Certified Landscape Technician (CLT) - Exterior, with installation, maintenance, specialty areas, designated CLT-Exterior.
- B. Licensed Arborist required to submit one copy of license to Contracting Officer's Representative.
- C. Independent or university laboratory, recognized by State Department of Agriculture, with experience and capability to conduct testing indicated and that specializes in types of tests to be performed.
- D. Measure plants according to ANSI Z60.1. Pruning to obtain required sizes will not be permitted.
- E. Contracting Officer's Representative may review plant materials either at place of growth or project site before planting for compliance with requirements. Contracting Officer's Representative retains right to inspect trees and shrubs to determine if any unacceptable conditions exist and to reject any trees or shrubs at any time during Project. All rejected trees and shrubs must be immediately removed from Project site.
 1. Submit plant material source information to Contracting Officer's Representative ten days in advance of delivery to Project site.
- F. Material Test Reports: For standardized ASTM D5268 topsoil, existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil.
 1. For each unamended soil type, provide soil analysis and written report by qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation

exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of soil.

2. Comply with USDA's Handbook No. 60 testing methods and written recommendations.
3. Soil-testing laboratory to oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Contracting Officer's Representative. Take minimum 3 representative samples from varied locations for each soil to be used or amended for planting purposes.
4. Report suitability of tested soil for plant growth.
5. Based on test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per 1 cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
6. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.8 DELIVERY

- A. Deliver packaged products in manufacturer's original sealed packaging.
- B. Bulk Products:
 1. Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.
 2. Install erosion control materials to prevent erosion or displacement of bulk products.

1.9 STORAGE AND HANDLING

- A. Store seeds and other packaged materials in dry locations away from contaminants.
- B. Topsoil: Before stockpiling topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation three to four weeks before stockpiling existing topsoil.

1.10 FIELD CONDITIONS

- A. Environment:

1. Coordinate installation of seed during the spring season.
 2. Restrictions: Do not plant when ground is frozen, snow covered, muddy, or when air temperature exceed 90 degrees F.
- B. Weather Limitations: Install plantings only during current and forecasted weather conditions that are comply with plant requirements. Apply associated products in compliance with manufacturers' instructions.

1.11 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."
- B. Manufacturer's Warranty: Warrant plantings and against material defects.
1. Warranty Period: Two years.
 2. Plant and Turf Warranty Periods will begin from date of Government acceptance of project or phase for beneficial use and occupancy.
 3. Contracting Officer's Representative will reinspect seeded area at end of Warranty Period. Replace any dead, missing, or defective plant material immediately. Warranty Period will end on date of this inspection provided Contractor has complied with warranty work required by this specification. Comply with following requirements:
 - a. Replace any plants more than 25 percent dead, missing or defective plant material before final inspection.
 - b. Only one replacement of each plant will be required except when losses or replacements are due to failure to comply with these requirements.
 - c. Complete remedial measures directed by Contracting Officer's Representative to ensure plant and turf survival.
 - d. Repair damage caused while making plant or turf replacements.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Provide each product from one source or manufacturer.
- B. Sustainable Construction Requirements:
1. Select products with recycled content to achieve overall Project recycled content requirement.
 - a. Fertilizer.

2.2 SEED

- A. Grass Seed: State-certified, State-approved, Endophyte-enhanced seed of latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will not be acceptable. Field mixes will be acceptable when field mix is performed on site in presence of Contracting Officer's Representative.
- B. Seed Mixtures: Proportion seed mixtures by weight.
 - 1. Full Sun: Proportioned grass species as follows:
 - a. 50 percent *Pseudoroegneria spicata* 'Anatone' bluebunch wheatgrass.
 - b. 30 percent *Pascopyrum smithii* 'Arriba' western wheatgrass.
 - c. 10 percent *Elymus lanceolatus* 'Sodar' thickspike wheatgrass.
 - d. 10 percent *Nassella viridula* 'Cucharas' green needlegrass.

2.3 PLANTING SOILS

- A. Planting Soil: Topsoil must be a minimum of 6 inches deep in all areas. Evaluate soil for use as topsoil according to ASTM D5268. From 5 to 10 percent organic matter as determined by topsoil composition tests of Organic Carbon, 6A, Chemical Analysis Method described in USDA DOA SSIR 42. Maximum particle size 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. Mix topsoil with following soil amendments and fertilizers as recommended by soils analysis.
- B. Existing Planting Soil: Existing, native surface topsoil formed under natural conditions retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Supplement with another specified planting soil when quantities are insufficient.
 - 2. Mix existing, native surface topsoil with soil amendments and fertilizers as recommended by soils analysis.
- C. Imported Planting Soil: Imported topsoil or manufactured topsoil from off-site sources are acceptable if sufficient topsoil is not available on site to meet specified depth. At least 10 days before topsoil

delivery, notify Contracting Officer's Representative of topsoil sources. Obtain imported topsoil displaced from naturally well-drained construction or mining sites where topsoil is at least 6 inches deep. Topsoil from agricultural land, bogs, or marshes will be rejected.

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: Commercial grade hydrated or burnt limestone containing calcium carbonate equivalent (CCE) specified in ASTM C602 of minimum 80 percent.
- B. Sulfur: 100 percent elemental.
- C. Iron Sulfate: 100 percent elemental.
- D. Aluminum Sulfate: Commercial grade.
- E. Perlite: Horticultural grade.
- F. Agricultural Gypsum: Coarsely ground from recycled scrap gypsum board comprised of calcium sulfate dehydrate 91 percent, calcium 22 percent, sulfur 17 percent, minimum 96 percent passing through 850 micrometers 20 mesh screen, 100 percent passing through 970 micrometers 16 mesh screen.
- G. Coarse Sand: ASTM C33/C33M, clean and free of materials harmful to plants.
- H. Vermiculite: Horticultural grade for planters.
- I. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- J. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

- A. Organic Matter: Commercially prepared compost. Free of substances toxic to plantings and as follows:
 - 1. Organic Matter Content: Wood cellulose fiber, wood chips, ground or shredded bark, shredded hardwood, bark peelings, pine straw mulch, pine needles, from project site when available. Biobased content 100 percent. Wood cellulose fiber processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to appropriate color to facilitate visual metering of materials application.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Composted Derivatives: Ground bark, nitolized sawdust, humus, or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having following properties:
1. Particle Size: Minimum percent by weight passing:
 - a. No. 4 mesh screen: 95.
 - b. No. 8 mesh screen: 80.
 2. Nitrogen Content: Minimum percent based on dry weight:
 - a. Fir sawdust: 0.7.
 - b. Fir or pine bark: 1.0.
 3. Biobased Content: 100 percent.
- C. Manure: Well-rotted, horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.6 PLANT FERTILIZERS

- A. Soil Test: Evaluate existing soil conditions and requirements before fertilizer selection and application to minimize use of all fertilizers and chemical products. Obtain approval of Contracting Officer's Representative for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions before application. Apply products during favorable weather and site conditions according to manufacturer's instructions and warranty requirements. Fertilizers to be registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer applicable to specific areas as required for Project conditions and application. Provide commercial grade plant fertilizers, free flowing, uniform in composition and conforms to applicable state and federal regulations.
- B. Provide fertilizer for grasses as recommended by seed supplier, except synthetic chemical fertilizers are not acceptable. Fertilizers containing petrochemical additives or that have been treated with pesticides or herbicides are not acceptable.

- C. Granular Fertilizer: Organic, granular controlled release fertilizer containing minimum percentages, by weight, of plant food nutrients.
 - 1. Composition: Nitrogen, phosphorous, potassium, sulfur, and iron in amounts recommended in soil reports from qualified soil-testing laboratory.
- D. Fertilizer Tablets: Organic plant tablets composed of tightly compressed fertilizer chips, insoluble in water, to provide continuous release of nutrients for minimum 24 months and containing following minimum percentages, by weight, of plant food nutrients:
 - 1. Nutrient Composition: 20 percent available nitrogen, 20 percent available phosphorous, and 5 percent available potassium.

2.7 ANTIDESICCANT

- A. Antidesiccant: An emulsion specifically manufactured for agricultural use that will provide protective film over plant surfaces permeable enough to permit transpiration.

2.8 EROSION CONTROL

- A. Erosion Control Blankets: Slow degrading natural or polymer fibers mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix or an open weave textile composed of processed slow degrading natural or polymer yarns or twines woven into a continuous matrix, designed to degrade within 18 to 24 months. Refer to Wyoming Department of Transportation publication "Pollution Controls and Best Management Practices for Storm Water During Construction".
- B. Erosion Control Material Anchors: As recommended by erosion control material manufacturer.
- C. Shape, finish, seed and fertilize areas as specified before placing erosion control materials. To achieve maximum blanket-to-soil contact, roll out blankets evenly and smoothly without stretching. Overlap lengthwise blanket edges at least 2 in and with the direction of prevailing winds to minimize overturning. Embed the non-overlapping ends of the initial blankets in 6 in wide × 6 in deep check slots the full width of the blanket. Staple blankets to the ground using U-pin staples driven vertically through the material. Use a single staple common to both blankets at overlapped ends and edges. Place staples at intervals of 4 ft along overlapping lengthwise edges and at intervals

of 3 ft along overlapping ends and the bottom of check slots. Inspections and maintenance should ensure that the blankets are stationary, continue to be in contact with the grade, are providing full coverage, have not degraded prior to germination.

2.9 BIOSTIMULANTS

- A. Biostimulants: Formulation containing soil conditioners, VAM fungi, and endomycorrhizal and ectomycorrhizal fungi spores and soil bacteria appropriate for existing soil conditions.

2.10 WATER

- A. Water: Source approved by Contracting Officer's Representative and suitable quality for irrigation, containing no elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

2.11 PESTICIDES

- A. Consider IPM (Integrated Pest Management) practices to minimize use of all pesticides and chemical products. Obtain Contracting Officer's Representative's approval for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions before application. Apply products during favorable weather and site conditions according to manufacturer's instructions and warranty requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 1. Verify that no materials that would inhibit plant growth are present in planting area. If such materials are present, remove soil and contaminants as directed by Contracting Officer's Representative and provide new planting soil.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations if soil moisture becomes excessive. Resume soil preparations when moisture content returns to acceptable level.

4. If soil is excessively dry, not workable, and too dusty, moisten uniformly.
 5. Special conditions may exist that warrant variance in specified planting dates or conditions. Submit written request to Contracting Officer's Representative stating special conditions and proposed variance.
- B. Proceed with planting operations only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect existing and proposed landscape features, elements, and site construction and completed work from damage. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on drawings.
- B. Install erosion control materials at all areas inside or outside limits of construction that are disturbed by planting operations. Provide erosion control and seeding with native plant species to protect slopes.

3.3 SEEDING

- A. Drill Seeding: Drill seed at rate recommended by local seed supplier. Use grass seed drills. Drill seed uniformly to 1/2 inch deep. Use a non-selective herbicide such as glyphosate at the same time as seeding to reduce weed competition.
- B. Rolling: Immediately after seeding, firm entire area, except for slopes in excess of 3 to 1, with roller not exceeding 90 lb./ft. of roller width.

3.4 PLANT MAINTENANCE

- A. Frequency: Begin maintenance immediately after plants have been installed. Inspect seeded area at least once week and perform required maintenance promptly.
- B. Promotion of Plant Growth and Vigor: Water, prune, fertilize, mulch, eradicate weeds, and perform other operations necessary to promote plant growth and vigor.

3.5 SLOPE EROSION CONTROL MAINTENANCE

- A. Provide slope erosion control maintenance to prevent undermining of all slopes in newly landscaped and natural growth areas. Maintenance tasks include immediate repairs to weak spots in sloped areas and maintaining clean, clear culverts and graded berms and terraces to intercept and direct water flow to prevent development of large gullies and slope erosion.
 - 1. Fill eroded areas with amended topsoil and replant with same plant species.
 - 2. Reinstall erosion control materials damaged due to slope erosion.

3.6 CLEANING

- A. Remove and legally dispose of all excess soil and planting debris.

3.7 PROTECTION

- A. Protect plants from traffic and construction operations.
- B. Provide temporary fences or enclosures and signage, at planted areas. Maintain fences and enclosures during maintenance period.
- C. Remove protective materials immediately before acceptance.
- D. Repair damage.

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SECTION 33 08 00**COMMISSIONING OF SITE UTILITY SYSTEMS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 31.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This Section includes requirements for commissioning the Facility site utilities systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 31 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 31, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility site utilities systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements:

1.6 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION****3.1 CONSTRUCTION INSPECTIONS**

- A. Commissioning of Site Utility systems will require inspection of individual elements of the site utility systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule site utility systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of

checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 31 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be

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scheduled in coordination with the VA Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 31 Sections for additional Contractor training requirements.

----- **END** -----

SECTION 34 71 13
PASSIVE VEHICLE BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stationary anti-ram rated vehicle barriers near concrete pad that supports air fuel mixer skid.

1.2 RELATED REQUIREMENTS

- A. Pipe Bollards: Section 05 50 00, METAL FABRICATIONS.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. ASTM International (ASTM):
1. F2656/F2656M-15 - Crash Testing of Vehicle Security Barriers.
- C. United States Department of State (DS):
1. SD-STD02.01-Revision A - Vehicle Crash Testing of Perimeter Barriers and Gates.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
1. Show size, configuration, and fabrication and installation details.
 2. Show dimensions and clearances between barriers and other adjacent permanent construction.
 3. Include setting drawings and templates for anchors embedded into concrete foundations.
- C. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.

1.5 QUALITY ASSURANCE

- A. Mockups: Construct full sized mockup at project site directed by Contracting Officer's Representative.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify field conditions affecting vehicle barrier fabrication and installation. Show field measurements on Submittal Drawings.

1. Coordinate field measurement and fabrication schedule to avoid delay.

1.7 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Structural Vehicle Barriers:
 1. Bollards: Steel pipe, concrete filled. See Section 05 50 00, METAL FABRICATIONS.
 2. Foundations: As indicated on drawings.

2.2 SYSTEM PERFORMANCE

- A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify foundation suitability for product installation.

3.2 INSTALLATION

1. Bollard Installation: See Section 05 50 00, METAL FABRICATIONS.

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